

THE DISTRIBUTION AND ANALYSIS OF ALL THE STREAMS ON THE
KANSAS STATE UNIVERSITY PILOT FLOUR MILL

by *LL*

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INTRODUCTION

The purpose of this study was to investigate quantitatively the distributions of stock of several different wheats to and from each milling machine on a production scale flour mill. The quantitative part of the study measured the flow rate of stock at every point in the mill. Some factors normally associated with the qualitative evaluation of flour and the milling process were necessary to complement the quantitative study. The qualitative portion of such a study must consider weight and such quality factors as ash and protein.

Farrell and Ward (10) pointed out the lack of such information and also noted its uses "1) to improve quality or yields or both; 2) to select or adapt sifter screen openings better suited to the machines that process one or more particular streams; 3) to design the flow diagram for new flour mills; 4) to predict in pounds per minute how much each pneumatic lift must carry in the design of pneumatic lifts." Hence the importance of the quantitative aspect of this study.

In the production of white flour for baked products the ash content of the flour has long been used as one of several standards of quality. Ash can be defined as mainly inorganic matter which remains after a sample has been incinerated at 550°C. for 10 hours. The ash is known to be more concentrated in the outer covering or bran and germ of the wheat kernel than in the starchy endosperm. Since the major concern in the milling of wheat into white flour is the clean separation of the low ash endosperm from the high ash bran and germ, the efficiency of the separation can be judged approximately from the ash content of the flour produced. In laying

out the flow of a new mill, or to improve the flow of an existing mill, it is essential to be able to estimate the probable ash in each stream to avoid contamination of low ash stock with stock with much higher ash. Of course the particle size of the stock and the availability of equipment must be taken into account when originating or altering the flow of a mill.

This study was conducted on the Kansas State University Pilot Flour Mill. The capacity of the mill is 200 weights per 24 hours. The mill uses pneumatic conveying and gravity for the movement of stock to the various systems. The air temperature and humidity in the mill rooms were automatically controlled. Flow sheets of the mill as it was used for the wheats concerned and a list of the production equipment in the mill are presented in the section Methods and Materials.

The wheats milled consisted of two samples of hard red spring wheat, one soft red winter wheat, one soft white wheat (Gaines), and five hard red winter wheats. Each of these wheats are more fully described in the section Methods and Materials. Farrell and Ward (10) conducted a similar study on the same flour mill using two hard red winter wheats. Some of their data for this class of wheat was used in this study.

SURVEY OF LITERATURE

A study of practical flour milling must start with a sound knowledge of the structure of the wheat kernel. Bradbury et al. (4) in their studies of the structure of the wheat kernel divided the berry into five general parts; the pericarp, seedcoat and pigment strand, nucellar epidermis and nucellar projection, endosperm and germ. King (21) and Bates (2) showed

some very clear pictures of these structures. Senti and MacLay (36) described the relation of the parts of the bran with the endosperm.

The pericarp, which represents four to six percent of the total (4) weight of the kernel, is the outermost covering of the kernel and can be divided into six distinguishable layers. Just inside the pericarp and firmly bound to it is the seed coat which encompasses the embryo and endosperm and is joined at the pigment strand in the crease. The pigment strand and the nucellar projection lie along the crease with the latter being the joining point of the nucellar epidermis. The nucellar epidermis is a single layer of cells tightly compressed between the seed coat and the endosperm and strongly united to both.

The outermost layer of the endosperm is composed of thick walled cells which contain no gluten or starch. These cells are the aleurone layer of the endosperm. Bran, as the term is used in flour milling, includes the aleurone layer and all that is outside of it (24). Thus there is no distinct cleavage line between the remaining endosperm, the aleurone and the bran. The remaining endosperm without the aleurone is often referred to as starchy endosperm, and is made up of cells containing starch granules embedded in proteinaceous material. The endosperm usually accounts for approximately 80 to 86 percent of the weight of the kernel.

The germ is the living portion of the seed, containing the embryo and its parts. It is located in one end of the oval shaped berry. The germ is covered on the outside by the seed coat and is not tightly bound in the kernel (4). By weight the germ is two to three percent of the kernel.

MacMasters et al. (24) gave a quantitative relation of the milled

fractions of the wheat kernel as follows: bran 14 to 16 percent, starchy endosperm 81 to 84 percent, germ 2.5 to 3.5 percent by weight. Though not a distinct mill fraction, aleurone was listed as 6.7 to 7.0 percent of the kernel by weight (40 to 50 percent of the bran). The ash of each fraction was also listed as a percent of ash in the fraction and as a percent of the ash in the whole kernel.

Ash in fraction		Percent of total ash in kernel
bran	4.8 to 6.7%	68.
endosperm	.26 to .55%	20.
germ	3.65 to 9.47%	12.

The ash in the aleurone layer was said by MacMasters et al. (24) to be 14.37 to 17.2 percent. They then listed this as about 61 percent of the ash in the kernel. From this it becomes clear that the ash of the wheat kernel is concentrated in the aleurone layer. This leads to the statement (24) that color grade value and ash content of flour are not significantly related since aleurone particles will greatly alter the ash of the flour but will not appreciably affect the color grade value.

Morris et al (29), working with one variety each of three classes of wheat (hard red winter, hard red spring, and soft red winter), showed by separating the endosperm from five areas that the ash increased going from the center to the periphery of the endosperm. Hinton (14), working separately, found similar distributions of ash in the endosperm. Morris et al (27) found the bran to contain 13 to 18 times as great a percent of ash by weight as the entire starchy endosperm.

The difference in ash content between endosperm and bran makes the ash content of the flour a sensitive indicator of the efficiency of the

separation of low ash flour from the high ash bran. When first discovered, ash differences were used to guide milling process control. Soon flour ash was used in pricing flour and its importance got out of proportion to its value in estimating flour baking quality. It has since been shown (19, 30) that baking quality of flour is not necessarily indicated by its ash content. Ash is still, however, a valuable tool to the miller in his own mill in measuring the efficiency of the separation of the endosperm from the bran.

Shuey (37) gave as "yardsticks for measuring milling values of wheats, and their milling characteristics" flour yield, both patent and total flour, the milling rate of the wheat, the temper required, both as to time and amount, and the ash of the flour. The factors influencing flour ash were divided into three main classes, environmental influences, hereditary influences, and physical treatment. The first two of these can be controlled by the miller only by selective purchasing. The third however can essentially be controlled by the miller. It was subdivided into handling and storage of wheat, cleaning, tempering or conditioning, and milling of wheat. Robbins (31) gave a somewhat similar set of factors effecting ash in flour.

A flour mill is a continuous integration of many operations to obtain a common goal, the production of the largest possible quantity of white flour suitable to the consumer's needs, from the smallest possible quantity of wheat. Bouskill (3) divided the actual milling process into five operations, breaking, grading, purifying, reducing, and dressing or bolting the endosperm. The conditioning and treatment of the wheat prior to milling must also be taken into account when considering the overall performance

of a flour mill on a given wheat. Each of these is a distinctly different operation but each depends upon the previous operations. Each operation will affect the subsequent operations, but to a diminishing degree as available endosperm becomes less toward the end of the milling manufacturing process. Each of the operations involved in the production of white flour is an important factor in the overall process but none can individually be responsible for the success of the entire process. On the other hand however, any one operation can cause the overall process to fall short of its goal. Each operation can be evaluated separately from the rest of the mill but the true story is not told until they are evaluated as an integrated process.

One method of evaluating the overall process is by plotting the cumulative ash curve of all the flour streams in the mill. This is a valuable tool in evaluating the performance of the mill and the milling value of the wheat (10, 44). Wisnar (44) gave some of the background and development of the use of cumulative ash data. This method derives its value from the fact that it takes into account both ash and quantity of all the flour streams at once.

Miller (26) pointed out that by shifting the bulk of the flour production toward the tail of the mill it would be possible to decrease the ash content of every stream in the mill and still have increased straight grade ash. Such a situation would be quite difficult to correctly analyze by investigating only the qualitative data of the individual flour streams. The shape of the cumulative ash curve would make this clear at a glance since it would rise more uniformly along its entire length.

Rozsa (32, 33, 34) presented a short history of the development of the use of granulation curves and their use in controlling and balancing a mill. He stated that once it is determined that the mill is in balance and operating properly the granulation curve should remain constant from day to day. Rozsa (33) stated further that the curves should be used to indicate changes in roll corrugations (worn corrugations), roll settings, sifter efficiency, wheat temper, general milling condition of the wheat, and hence the balance of the mill.

Rozsa (32) presented the flow sheet of the 1000 barrel hard winter wheat flour mill from which the data he used were taken. The data were first published by Hodges (15, 16, 17). Hodges gave the weight, in pounds, of every stream in the mill. Each stream was also given as a percent of the section from which it originated. Rozsa (32) gave a tabled analysis of the disposition of the milling equipment throughout the mill as well as the loading of the equipment.

Rozsa (34) used the data previously presented by himself (32) "to demonstrate how the application of the 'granulation curve' may be useful in reviewing the operation of a flour mill." In so doing he presented the granulation curves of all the breaks and nearly all of the reductions.

Farrell and Ward (10) gave the distribution of stock throughout the Kansas State University Pilot Flour Mill. The weight of each stream was accompanied by the ash and protein of the stream. These analyses help to give meaning to the flow of the mill since not only particle size but also the ash of the stock is considered when a flow is developed. In the same article they demonstrated one use of the data by giving an example of how

granulation curves can be used in developing a new flow sheet or improving an existing one. The authors pointed out the importance of predicting the flow rates of the various streams in a mill when designing pneumatic systems.

Several other mills have been described in the literature by the use of stream weights and analyses but they are incomplete in their analyses and stream weights. Scott (35) presented a flow sheet of an English mill (50 sacks of flour each 280 pounds per hour) which produced 3360 hundred weights per 24 hours. The flow sheet includes the flow rates of most of the streams but no description of the wheat was given and no analyses were included.

Scott (35) discussed the comparative granulation of stock ground from hard and soft wheats. In so doing it was convenient to consider the initial breaks and the tailend breaks separately. Scott (35) stated that "At normal milling moisture values, the release with equal roll settings is usually higher on the first and second break rolls for soft wheats than for hard." Granulation curves were presented to verify this break release difference between No. 3 Manitoba (hard) and Russian (soft) wheat. "On the later break rolls the release from soft weak grain is usually low because of the relatively high initial release and because the skin is tough and remains in large fragments to which the endosperm adheres tenaciously. For the reverse reasons the release from strong dry brittle-skinned wheats are comparatively high on the final breaks."

Miller (26) gave a comprehensive verbal description of the stock throughout a flour mill of undisclosed capacity. Diagrams of each sifter and purifier section gave the flow rate and analyses of most of the streams.

The wheat was described as hard red winter but the analyses were not given for all the streams.

Jurker (12) studied sifter performance in a hard wheat flour mill which milled 5557 pounds per hour of hard wheat. The weights of the streams leaving each sifter in the mill were given in pounds per hour and as a percent of the wheat sent to first break. Since the study was concerned only with the physical separations made by the sifters no chemical analyses were made.

Gohle (13) described a method of designing pneumatic conveying systems by expressing the weight of each stream in the mill as a percent of stock to first break. Using this method Gohle theorized a method of reducing necessary conveying capacity and hence power consumption.

METHODS AND MATERIALS

Nine samples of wheat from four classes were milled in this study. Five of the samples were hard red winter wheats, two were hard red spring wheats, one was a soft red winter, and one was a soft white wheat. Each sample came from an area of the United States in which its class of wheat is commonly grown (Table 1). Hereafter each sample will be referred to by the abbreviated names which appear in parenthesis in Table 1.

Of the two hard red spring wheats, one was relatively high in protein content and the other was low in protein. For this reason they have been referred to as hard red spring low protein and hard red spring high protein throughout this study. The soft white wheat was the well known Gaines variety and so was referred to as Gaines for this work. The hard red winter wheats were made up of one low protein wheat, one high protein wheat,

Table 1. Description of wheats.

Wheat	Description of origin
Hard red winter low protein (HRW-L)	Blackwell, Oklahoma, dominant variety in the Blackwell area was Triumph.
Hard red winter high protein (HRW-H)	Burdett, Kansas, probably a mixture of Early Triumph and Bison.
Hard red winter (HRW-1)	Blended to 11.5% protein from several bins of wheat grown near Manhattan, Kansas, in 1964.
Hard red winter (HRW-2)	Blended to 11.2% protein from several bins of wheat grown near Manhattan, Kansas, in 1965.
Hard red winter (HRW-3)	Blended to 11.9% protein from wheats from several locations all in Kansas.
Hard red spring low protein (HRS-L)	Grown near Choteau, Montana, the predominant varieties in the Choteau area were Ceres and Thatcher.
Hard red spring high protein (HRS-H)	Grown near Valley City, North Dakota, variety was believed to be a mixture of Pembina and Justin.
Soft white (Gaines)	Grown at Pullman, Washington, variety was Gaines which was the leader in the Idaho, Oregon, and Washington white wheat area.
Soft red winter (SRW)	Grown near Winchester, Indiana, where the variety Manor was rapidly becoming favored over Knox.

and three samples which were each blended to near 11.5 percent protein.

Some of the quality factors commonly used to evaluate wheats for milling value appear in Table 2.

Data from the milling of hard red winter wheats on the existing Kansas State University Pilot Flour Mill were reported by Farrell and Ward (10).

Table 2. Analyses of wheats.

	Range of values									
	1937-8	1938-9	1939-40	1940-1	1941-2	1942-3	1943-4	1944-5	1945-6	1946-7
Protein (%) [*] (max. 7)	10.7	13.3	11.2	11.5	11.9	11.1	13.8	9.2	11.8	
Ash (%) [*]	1.69	1.66	1.50	1.44	1.55	1.50	1.65	1.40	1.61	
Moisture (%)	13.5	12.1	14.0	10.4	11.2	14.0	11.2	12.0	14.7	
Test weight (lbs/bu)	63.0	62.6	56.9	61.2	57.4	61.4	59.6	64.5	61.7	
Pearling value (%)	59.7	62.2	63.5	69.2	67.5	65.5	63.7	60.5	59.0	
1000 kernel wt. (gm)	32.5	29.4	31.1	26.4	23.1	23.9	22.9	33.2	33.4	
Wheat size										
Over 7W (%)	78.0	57.0	76.0	46.0	65.5	72.0	41.5	60.0	33.5	
Over 8W (%)	21.5	42.0	23.5	53.0	34.0	27.0	57.5	31.5	14.5	
Over 12W (%)	0.5	1.0	0.5	1.0	0.5	1.0	1.0	0.5	0.0	

^{*} 14% moisture basis.

These data were used in this study as representative of the performance of the Pilot Flour Mill on Hard Red Winter wheat. This wheat is referred to in this paper as HRW.

A list of abbreviations used in this report are shown in Table 3.

Table 3. Abbreviations used.

Abbreviation	Definition
Bk. red.	1,2,3, break redust
1,2,3 Red	1,2,3 break redust
C. Siz.	coarse sizings
F. Siz.	fine sizings
T. Fl.	top flour (from upper series of flour cloths)
B. Fl.	bottom flour (from lower series of flour cloths)
1 M	first middlings
2 Q	second quality
1T	first tailings
Suc.	suction section
B.D.	bran duster
S.D.	shorts duster
B. & S.D.	bran and shorts duster section
P-1	purifier one
tt (TT)	Tuf-Tex sieve clothing
gg (GG)	grit gauze (silk) sieve clothing
XX	Swiss silk sieve clothing
+ (followed by sieve size)	overs of the indicated sieve
- (followed by sieve size)	thrus of the indicated sieve
HRS	hard red spring wheat
HRW	hard red winter wheat
SRW	soft red winter wheat
3 Bk. F	third break fine
3 Bk. C	third break coarse
4 Bk. F	fourth break fine
4 Bk. C	fourth break coarse
wt	hundred weight
T.P.	total products

Scott (35) discussed the comparative granulation of stock ground from hard and soft wheats. In so doing it was convenient to consider the initial breaks and the tailend breaks separately. Scott (35) stated that "At normal milling moisture values, the release with equal roll settings is usually higher on the first and second break rolls for soft wheats than for hard." Granulation curves were presented to verify this marked release difference between No. 3 Manitoba (hard) and Russian (soft) wheat. "On the later break rolls the release from soft wheat grain is usually low because of the relatively high initial release and because the skin is tough and remains in large fragments to which the endosperm adheres tenaciously. For the reverse reasons the release from strong dry brittle-skinned wheats are comparatively high on the final breaks."

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Jurkow (18) studied sifter performance in a hard wheat flour mill which milled 5557 pounds per hour of hard wheat. The weights of the streams leaving each sifter in the mill were given in pounds per hour and as a percent of the wheat sent to first break. Since the study was concerned only with the physical separations made by the sifters no chemical analyses were made.

Cable (13) described a method of designing pneumatic conveying systems by expressing the weight of each stream in the mill as a percent of stock

to first break. Using this method Gehle theorized a method of reducing necessary conveying capacity and hence power consumption.

Cleaning

Prior to conditioning and subsequent milling, each of the wheats was cleaned using the cleaning house facilities of the Kansas State University Pilot Flour Mill. The wheat was conveyed through the entire cleaning system by gravity flow and pneumatic conveying systems. An automatic dump scale followed by a constant flow gravity feeder maintained an even 60 bushel per hour flow of wheat to the cleaning equipment. The actual cleaning equipment consisted of a permanent magnet, pneumatic lift aspirator, milling separator, dry stoner and gravity table, disc separator (large), disc separator (small seeds), impactor-scourer-aspirator, and a duo-aspirator. The cleaned wheat flowed into a holding bin which was used to insure an adequate supply of wheat for a constant flow to the tempering system. The wheat was tempered immediately after being cleaned.

Tempering

The tempering equipment consisted of the holding bin mentioned above, a scale feeder, a pneumatic lift, and 43 feet of 6-in. standard screw conveyor turning 43 revolutions per minute used to mix the water with the wheat and to convey the wet wheat to the tempering bins. The tempering bins consisted of eight bins each having a capacity of 25 bushels.

All the samples milled for these tests were tempered using a cold conditioning procedure, using different final moisture levels for the hard

and soft wheats. The scale feeder was adjusted to deliver a constant flow of 60 bushels per hour to the conditioner. The tempering water was added in one metered stream as the wheat entered the conditioner. The water and the wheat were both at room temperature.

The moisture of the wheat flowing to the scale feeder was determined using a Reg Hygrometric moisture tester (7). Using this moisture as the untempered wheat moisture, the necessary amount of water for tempering to the desired moisture level was calculated using the following formula:

$$\frac{100 + M_1}{100 + M_2} \times R_1 + R_2 = X$$

M_1 = percent moisture in the untempered wheat
 M_2 = percent moisture desired in tempered wheat
 R_1 = flow rate of untempered wheat
 X = flow rate of water to be added

The tempered wheat was held in the tempering bins for 20 hours prior to milling.

Upon milling, the tempered wheat was drawn from all eight tempering bins simultaneously. This was done to insure that a uniform blend of tempered wheat was sent to the mill.

The Wheat to Pre-break

The blended and tempered wheat was sent through a brush machine as it came from the tempering bins. From the brush machine the wheat was pneumatically conveyed to an automatic dump scale on the top floor of the flour mill. The dump scale was set to release 60 pounds per dump. A counter

attached to the release mechanism recorded the number of dumps made by the scale. The time cycle between dumps was set on an electric timer to deliver wheat at the rate desired for the mill.

The belt feeder continuously regulated the flow of wheat over the belt and automatically corrected its feed gate to deliver a constant flow at the rate of wheat desired to go to the mill.

The feed rate which the feeder was to maintain was set according to the capacity desired on the mill for the particular class of wheat being milled. Once set, a counter recorded the quantity of wheat delivered to the mill. Thus a double check of the total quantity of wheat sent to the mill and the rate at which it was milled was possible.

To facilitate optimum performance of the pilot flour mill on each of the various classes of wheats the moisture of the tempered wheat and the rate at which it was milled were varied. Several warm-up or trial millings were performed with both of the soft wheats and the two hard red spring wheats.

From these warm-up runs it was determined that the hard red spring wheats could be milled under the same conditions normally used in the pilot mill for hard red winter wheats. All of the hard wheats milled in this study were milled at 16.0 percent moisture and were delivered to the pre-break rolls at 18 bushels per hour.

It was found that both the soft wheats could be milled well at 15.0 percent moisture. The SNW wheat was delivered to pre-break at 16.0 bushels per hour and the Gaines was milled at 14.5 bushels per hour.

The Pilot Flour Mill

The Kansas State University Pilot Flour Mill has a production capacity of 250 weights of flour per 24 hours on hard wheats. Although this is somewhat small in comparison to most present commercial flour mills, special care was taken in the use and allocation of the available equipment so that the pilot flour mill could simulate most performance by ordinary commercial plants. The ash of the straight grade flour from the pilot mill is usually lower at a corresponding yield than is common in most commercial plants. Otherwise flour production and its by-products are most often accepted as analogous to those from larger mills.

Conveying of stock through the mill is entirely by pneumatics and gravity to the milling equipment distributed over four and one half floors. The temperature and relative humidity within the milling rooms was controlled automatically. The temperature was maintained at 80 ± 5 degrees Fahrenheit and the relative humidity was held at approximately 70 percent.

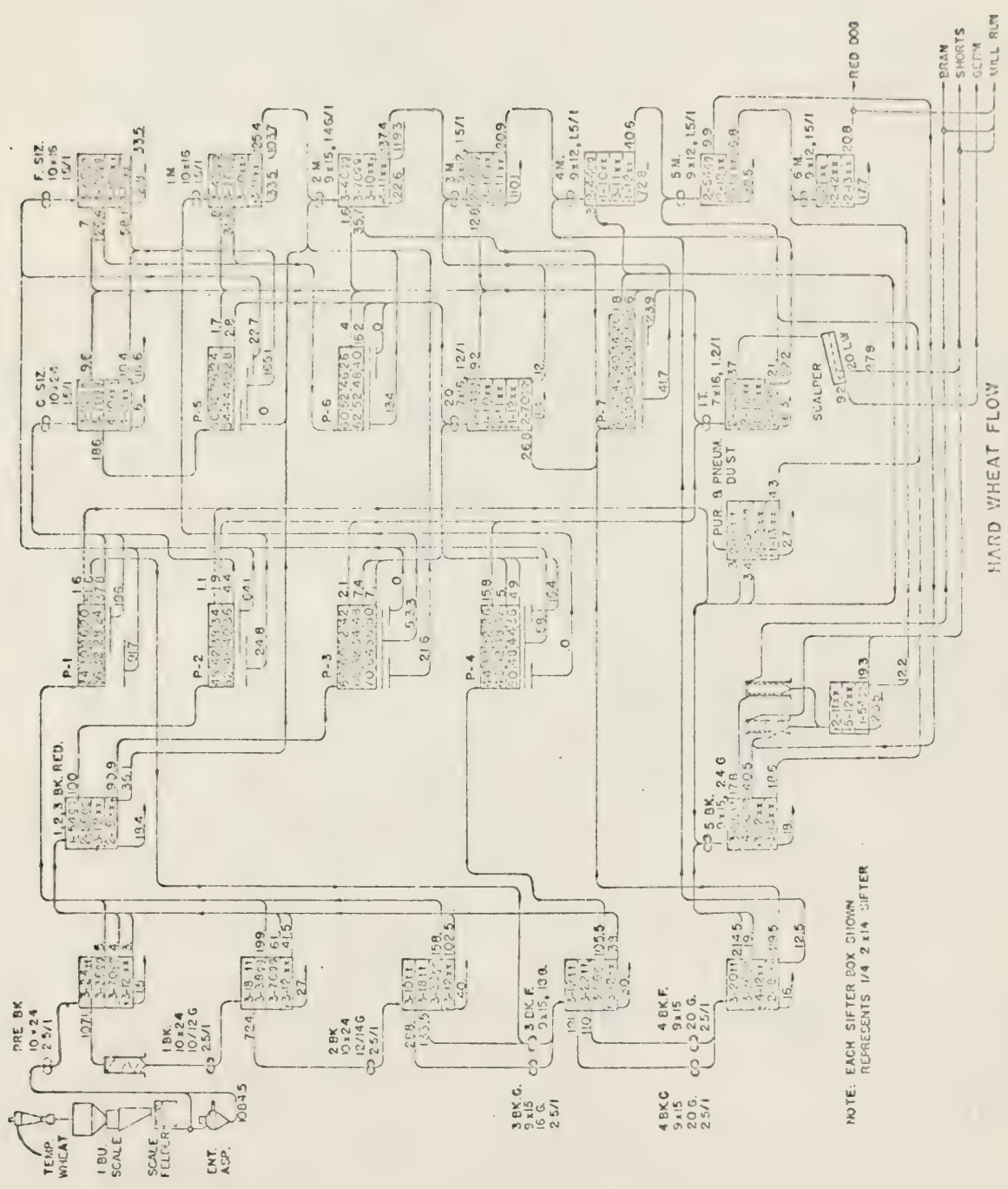
The flow diagrams of the pilot mill as it appeared when each sample was milled appear as follows: HRS-L, Plate I; HRS-H, Plate II; Gaines, Plate III; SNW, Plate IV; HSW, Plate V. The flow rates in pounds per hour stream in the mill appear near the represented stream on the flow sheet for each of the wheats.

Prior to this study the pilot mill was flowed solely for milling hard wheats. While attempting to keep the changes in the flow to a minimum, it was necessary to make certain changes in sifter clothing. These changes were determined from a series of warmup millings on the hard red spring and soft wheats. The changes are shown in Fig. 1.

EXPLANATION OF PLATE I

The flow sheet of the pilot flour mill as it was when the hard red spring low protein wheat was milled. The flow rate of each stream is shown in pounds per hour.

FIGURE 1



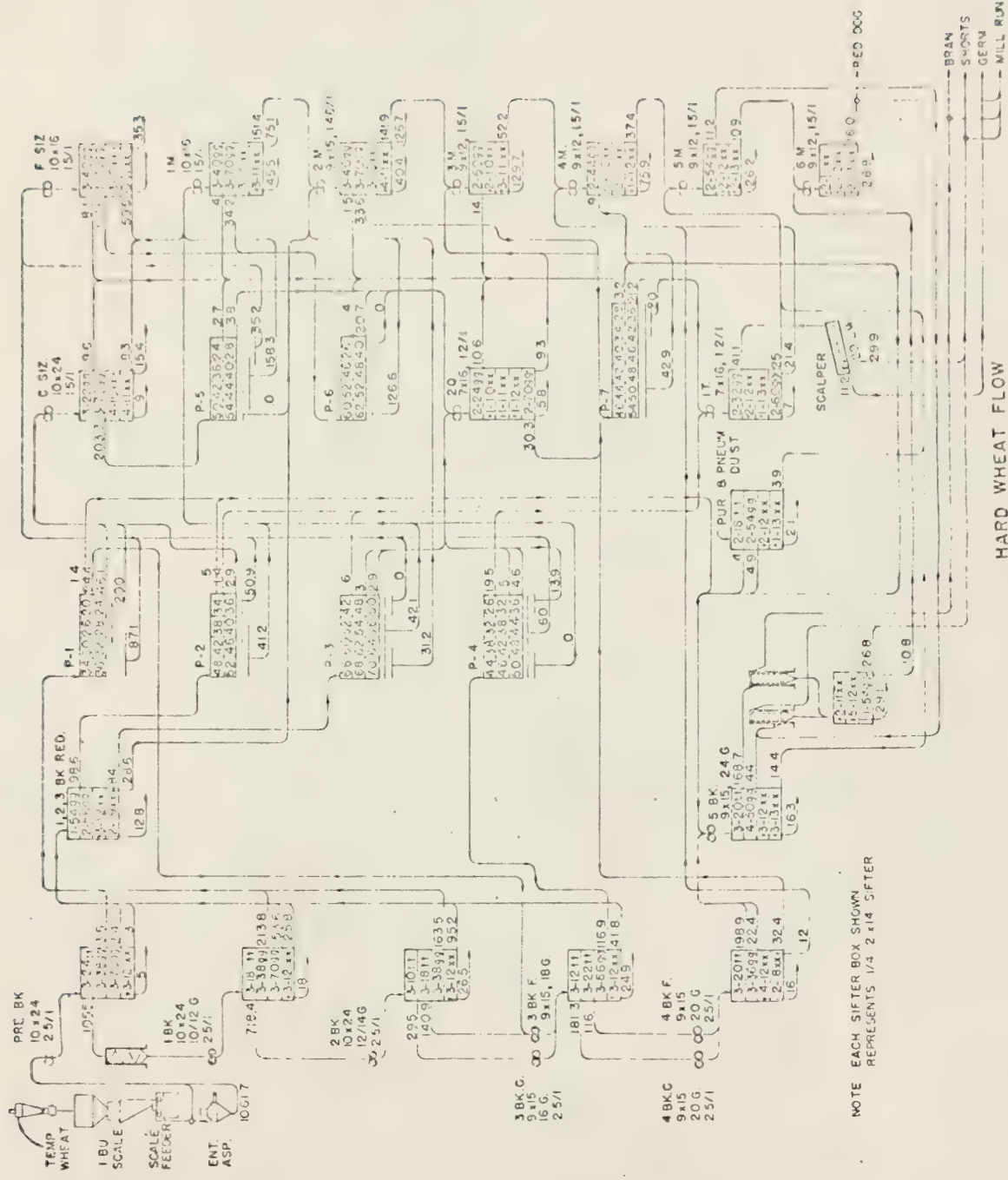
NOTE: EACH SIFTER BOX SHOWN REPRESENTS 1/4 2 x 14 SIFTER

HARD WHEAT FLOUR
H.R.S. LOW PROTEIN
KANSAS STATE UNIVERSITY
PILOT FLOUR MILL

EXPLANATION OF PLATE II

The flow sheet of the pilot flour mill as it was when the hard red spring high protein wheat was milled. The flow rate of each stream is shown in pounds per hour.

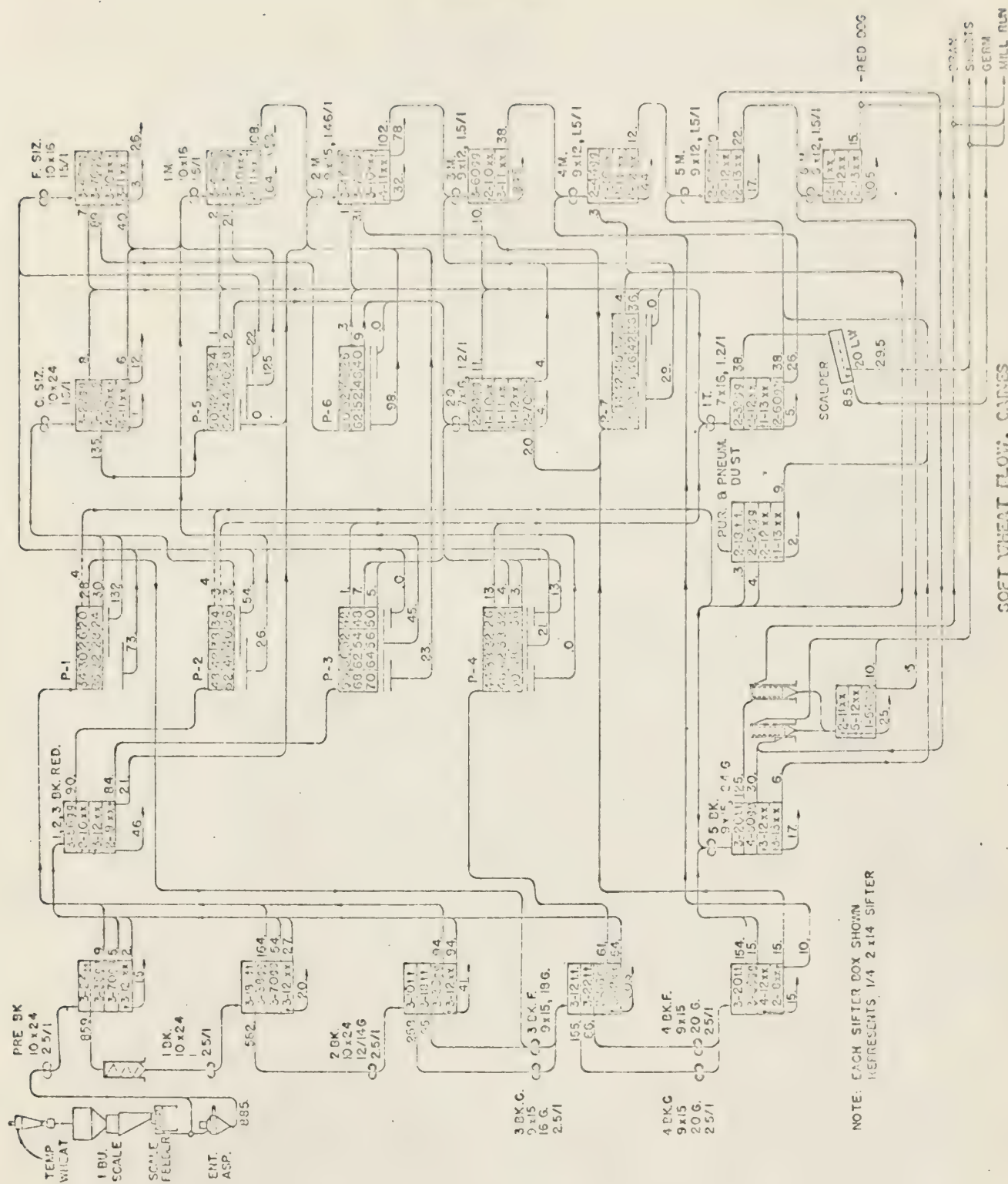
PLANT II



HARD WHEAT FLOW
H.R.S. HIGH PROTEIN
KANSAS STATE UNIVERSITY
PILOT FLOUR MILL

EXPLANATION OF PLATE III

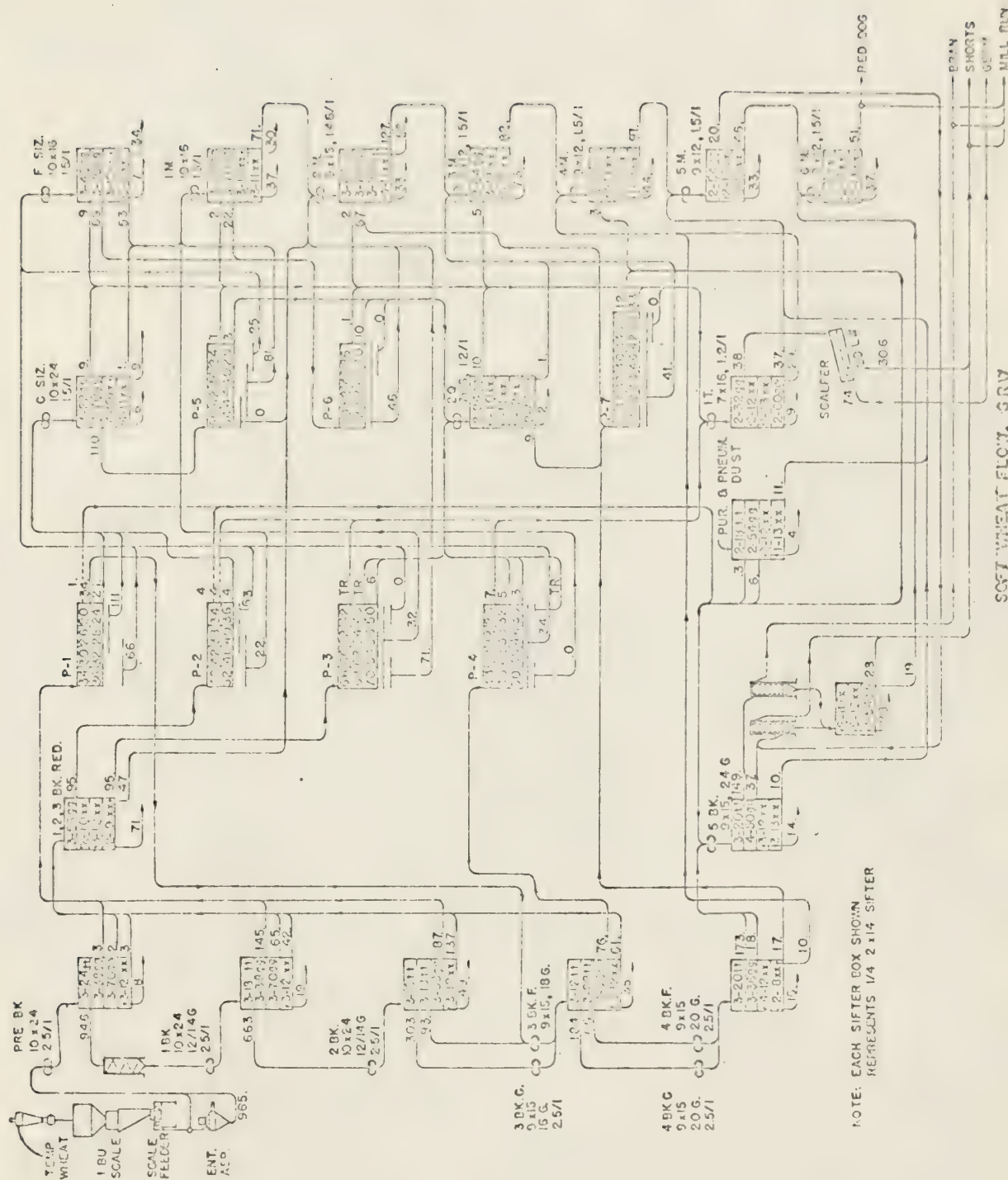
The flow sheet of the pilot flour mill as it was when the western white wheat was milled. The flow rate of each stream is shown in pounds per hour.



SOFT WHEAT FLOUR, CARBES
200 CWT FLOUR MILL
KANSAS STATE UNIVERSITY

EXPLANATION OF PLATE XV

The flow sheet of the pilot flour mill as it was when the soft red winter wheat was milled. The flow rate of each stream is shown in pounds per hour.



EXPLANATION OF PLATE V

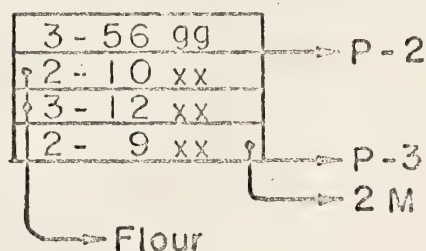
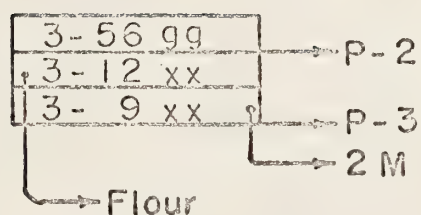
The flow sheet of the pilot flour mill as it was when hard red winter wheats were milled in a previous study. The flow rate of each stream is shown in pounds per hour.

SIFTER CLOTHING CHANGES

HARD WHEATS

SOFT WHEATS

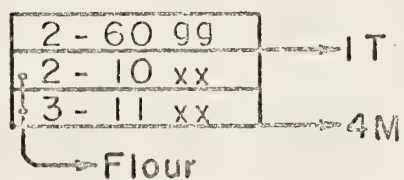
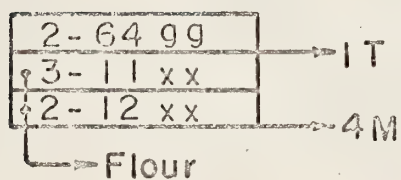
BREAK REDUST



HRW - L
 HRW - H
 SRW

HRW - 1 HRS - L
 HRW - 2 HRS - H
 HRW - 3 GAINES

THIRD MIDDS



FOURTH MIDDS

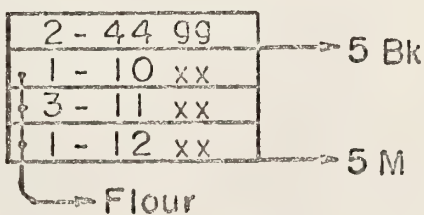
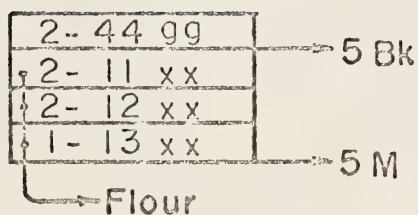


Fig. 1. Sifter clothing changes.

All the corrugated rolls (break rolls except pre-break) in the pilot mill ran with a 2-1/2 to 1 differential. The corrugations as indicated on the floor charts (Tables I, II, III, IV, and V) were the same throughout this study. All the smooth rolls in the pilot mill ran at 1 1/2 to 1 differential with the exception of 2Q and 1X which ran at 1.2 to 1 differential. The measured roll speeds of all the rolls are given in Table 4.

The amount of milling equipment used (rolls, sifters, and perforators) appears in Tables 4 and 5.

The Break System

The break grinding system of the pilot flour mill is made up of eight pairs of rolls divided into a pre-break using smooth rolls, and five breaks with corrugated rolls. Two pairs of rolls, one pair grinding coarse stock and the other grinding finer stock were used for both third and fourth break. A separate dustor was used on bran and end for shorts to complete the extraction of endosperm from bran.

The pre-break rolls were adjusted so that the kernels were just cracked along the crease. There was no attempt to release any endosperm from the kernel. The pre-break rolls are used only to prepare the kernel so that the first break rolls are able to release cleaner middlings.

The remainder of the breaks were adjusted by the use of a laboratory sifter to determine the break release obtained. The break rolls were set from head to tail of the mill, by adjusting either end of the rolls until they were grinding uniformly along their entire length. Then if necessary the entire roll was adjusted to obtain the desired release. The break

Table 4. K.S.U. Pilot Flour Mill, 200 cwt/24 hours, equipment allocation.

Stock	Roll Dia. (in.)	Length (in.)	Inches per cwt.	Roll speed rpm.	Sifter section	Number of sieves	Sq. ft. per cwt.	Sq. ft. per cwt.
Pre Dk	9.84	23.6	.118	263	1/4 2x14	12x1/2	15.6	.078
1 Bk	9.84	23.6	.118	265	1/4 2x14	12x1/2	15.6	.078
2 Bk	10.	24.	.120	300	1/4 2x14	12x1/2	15.6	.078
3 Bk F	8.67	15.75	.079	266	1/4 2x14	12x1/2	15.6	.078
3 Bk C	8.67	15.75	.079	376				
4 Bk F	8.67	15.75	.079	281	1/4 2x14	13x1/2	16.9	.084
4 Bk C	8.67	15.75	.079	265	1/4 2x14	13x1/2	16.9	.084
5 Bk	8.67	15.75	.079	280	1/4 2x14	13x1/2	16.9	.084
Bk red					1/4 2x14	8	20.8	.104
E.S.D.					1/4 2x14	8	20.8	.104
C. Siz	10.	24.	.120	300	1/4 2x14	14x1/2	18.2	.091
F. Siz	10.	16.	.080	316	1/4 2x14	12x1/2	15.6	.078
1 M	10.	16.	.080	316	1/4 2x14	12x1/2	15.6	.078
2 M	8.67	15.75	.079	370	1/4 2x14	14x1/2	18.2	.091
2 Q	7.	16.	.080	310	1/4 2x14	7	18.2	.091
3 M	9.	12.	.060	300	1/4 2x14	7	18.2	.091
1 T	7.	16.	.080	310	1/4 2x14	7	18.2	.091
4 M	9.	12.	.060	239	1/4 2x14	6	15.6	.078
5 M	9.	12.	.060	301	1/4 2x14	6	15.6	.078
6 M	9.	12.	.060	300	1/4 2x14	6	15.6	.078
Suc					1/4 2x14	7	18.2	.091
TOTAL		301.70	1.510				325.0	1.623

Table 5. Purifiers in the 200 cwt K.S.U. Pilot Flour Mill.

Purifier	Sieve area (ft ²)	Sq. ft. per cwt.
1	9.59	.0475
2	9.59	.0475
3	6.79	.0340
4	6.79	.0340
5	5.27	.0264
6	5.27	.0264
7	5.00	.0250
TOTAL	48.12	.2408

release was determined by sifting a 100 gram sample for 30 seconds over a 20 TT sieve. The overs of the sieve were weighed and subtracted from 100 percent (gross) to obtain the percent released. The same basic release schedule (Table 6) was used in all the tests.

Table 6. Through 20 TT.

1 Bk.....	30%
2 Bk.....	40%
3 Bk. F.....	30%
3 Bk. C.....	55%
4 Bk. F.....	30-35%
4 Bk. C.....	20%
5 Bk.....	35%

The Reduction System

The reduction system of the pilot mill consisted of two sizing operations, six middlings, a second quality, and a first tailings sections.

The two sizing sections were divided into coarse sizings and fine sizings. There was no attempt in either sizing section to produce any

flour. They were both adjusted for the purpose of reducing the size of the coarse middlings produced by the breaks and to remove and bran specks still adhering to the middlings. In so doing, the function of the siftings sections was three fold: 1) to flatten the germ so that it could be removed from the middlings as soon as possible; 2) to facilitate further cleaning of middlings by a purifier; and 3) to reduce the size of the coarse middlings so that the stock sent to the middlings rolls was of more uniform particle size.

The rolls of each of the six middlings sections were adjusted for maximum flour production without creating excess heat or flaking of the endosperm.

The second quality and first tails sections were adjusted for a purpose similar to that described for the sifting sections. The pilot mill was flowed so that the germ was concentrated at the first tailings rolls. Flattening the germ so that it could be removed to the germ separator by tailing over a 32 68 sieve in the 12 sifter was a major consideration in the adjustment of the first tailings rolls.

After the break rolls were all adjusted and operating properly, the reduction rolls were checked and set from head to tail of the system. The adjustment of the reduction system was governed largely by the appearance and feel of the ground stock as judged by the miller.

Bolting and Purification

As was mentioned previously (Fig. 1) it was necessary to use coarser flour cloths in some of the sifters while milling the soft wheats than when milling the hard wheats. These sifter clothing changes were kept to a

minimum in the break system by leaving the break sifters unchanged with the exception of the first, second, third break segment sifter where 12x flour cloths were added to the three 12x flour cloths which were always used for milling hard wheat.

After the SW wheat was milled, analysis of the data indicated that too much flour had tailed over the flour cloths of the reduction sifters and ended up in the bag. To correct this situation when Cairns was milled the third and fourth wide flour cloths were coarsened (Fig. 1). It was found that the coarser cloths in the 3A and 4A sifters were not detrimental to hard wheat milling and so they were left coarser when milling the remaining hard wheats (all the hard wheats except HRW-L and HRW-H).

The allocation of sifter surface by system is given in Table 4.

The purification system was made up of seven purifiers. The distribution of the available purifiers is shown in Table 5. The purifiers remained unchanged throughout the tests except that the air flow was varied in an attempt to keep the mill as nearly the same balance as possible. As was pointed out in a previous section of this report, the adjustment of the purifiers can be a very important factor in controlling the balance of flow in the mill.

Sampling

The mill was started and allowed to run until tempered wheat had spread throughout the mill. The rolls and purifiers were then adjusted in the manner already described. When the mill had stabilized and was running evenly the adjustments were rechecked and reset if necessary. After the mill was in

balance and running in a steady state the sampling process was begun.

The pilot mill was spouted so that all the flour streams flowed to a common sampling point where the individual flour stream samples of every flour stream in the mill could be taken in unison. These individual flour stream samples were collected over a five minute period. Immediately after collection the samples were weighed and bottles of each were tightly capped until the analyses could be run. The stream weights were recorded as grams per five minutes. The flour streams were sampled before and after the various other streams from each of the sifters and purifiers were sampled.

The remaining streams from the sifters (the flour streams were not re-sampled at the sifter) and the purifiers were sampled one system at a time in the reverse order of flow from the tail to the head of the mill. In this way each system to be sampled was not affected by the removal of the sample just collected. The streams flowing from the sifters were sampled by removing the socks beneath the sifter box and running the streams into sacks for five minutes. These samples were quickly weighed and smaller samples of each were bottled for analysis. The purifiers were sampled in a similar manner. The weights were recorded in grams per five minutes.

The four feed streams were weighed during the entire milling run on each wheat and saved for analysis. The pilot mill makes four millfeeds, bran, shorts, germ, and red dog. The shorts, germ and red dog were sacked off separately from the bran during the entire run on each wheat. The total weight of each stream was recorded. Later a representative sample of each was blended in a horizontal batch mixer and smaller samples were taken for analysis.

The Bran stream was sampled for five minutes three times each hour. The rest of the bran was run into a hopper scale where the total weight was recorded. The sacked samples were later blended in a horizontal batch mixer and sampled for analysis.

The entire mill was sampled during the milling of HWS-2, HWS-1, Galena, and SNW. Only flour and millfeed streams were sampled for weight and analysis during the milling of the hard red winter wheats. The sack weights and analyses already reported (19) from the pilot mill were used in this study as representative of hard red winter wheats.

Methods of Analysis of Streams and Wheat

The moisture, ash, and protein of each sample were determined by procedures 44-15, 60-11, and 46-11, respectively, in "Cereal Laboratory Methods" (6).

Test weights were determined using a one quart bottle and a beam balance in accordance with the standard method outlined by the United States Department of Agriculture (40).

The 1000 kernel weight was obtained by the use of an electronic seed counter to determine the number of kernels in a 40 gram sample. The count per 40 grams was then used to calculate the weight per 1000 kernels.

The pearling values were determined by pearling a 20 gram sample in a Strong-Scott barley pearling machine for 60 seconds. The pearled sample was then removed and sifted over a 20 wire sieve in a Sisco Laboratory sifter for 30 seconds. The portion of the samples remaining above the 20 wire was then weighed and recorded as a percent of the 20 gram sample.

Methods of Analysis of Performance Data

Rossa (32) presented flour production data on an entire mill. All the data was given in the form of tables. Latex, Rossa (33, 34) again presented the same data on the same mill but by the use of graphs. By so doing he pointed out the fact that the large quantity of data involved in considering a commercial flour mill as a single production unit are far more easily grasped in the form of a graph than in a table. A graph can show at a glance what tables yield only after some considerable study. For this reason much of the data obtained by this study has been represented graphically.

Rossa (33, 34) stated that the granulation curves of a given mill should not vary once they have been established in optimum performance conditions.

Parrell and Ward (18) pointed out the value of granulation curves in the design and analysis of a flour mill. They made use of the predictability of granulation within a mill to predict flow rates. Gehle (15) discussed a procedure of evaluating pneumatic conveying systems by expressing the quantity conveyed in each line (flow rates) as a percent of the load to the first grinding operation. Fairchild (9) used a similar method to evaluate pneumatic mills with different arrangements of milling machines. In the study, Fairchild used the Kansas State University Pilot Flour Mill as a basis for comparing various arrangements of equipment on single or multi-story buildings.

Break granulation data was also analysed using methods similar to those standardized by the American Society of Agricultural Engineers (12) for computing modulus of fineness and modulus of uniformity. Since a standard set of sieves was not used to determine the granulation data some modifications

was necessary. Each separation coming from the sifters was expressed as a percent of the total stock flowing from the sifter. Each separation was multiplied starting with zero times the finest separation and increasing the multiplier by one for each coarser separation. The products were then summed and the total represents the modulus of fineness as used in this study.

The modulus of uniformity was computed by dividing the sifter separations into three categories coarse, medium, and fine. The coarse stock varied from the overs of a 22 TT to the overs of an 18 TT. The medium stock varied from that an 18 TT and over 36 GG to thru 22 TT and over an 8 XL. All which passed the finer cloth of the medium range was called fine. The percent of stock in each size range was summed and divided by 10. The quotients, to the nearest tenth, were expressed as a ratio in the form, coarse to medium to fine.

The cumulative ash curve can be a valuable tool in the evaluation and operation of a flour mill. It can be used to evaluate the performance of a particular mill on different wheats or to relate the performance of several mills all milling the same wheat. Cumulative ash curves of total flour production are most often plotted with the cumulative percent of yield (total products in this study as the abscissa and the cumulative percent of ash as the ordinate).

When plotted, the cumulative ash of all the component streams of a straight grade flour should remain fairly flat (increasing slightly) until the cumulating percent yield approaches the percent of straight grade flour produced. As the total yield is approached the cumulative ash should rise

upward more rapidly. Once a mill is established in the production of a respectable flour yield at a reasonably low straight grade flour ash the cumulative ash curve can be used to evaluate future milling on that particular mill.

The cumulative ash curve and the accompanying data are also used to determine the rate of production of various flour grades to a specified ash level. It is in this use that the economic desirability of the cumulative ash curve shaped as just described in the previous paragraph becomes quite apparent. Low ash patent flour demands a price premium so the longer the cumulative ash stays low (relatively level curve) the more patent flour is available.

The various data from hard red winter wheat milling on the Kansas State University Pilot Flour Mill were used as the standard or control during this study. This data was taken both from wheat milled in this study and from data previously published by Farrell and Ward (10).

RESULTS AND DISCUSSION

Data for all the streams and the mill are given in Appendix A to this paper. It was necessary to work at all times with flow rates as a percent of either the wheat to the mill or the stock from the individual system, because the various wheats were milled at different rates.

The cumulative ash curves of all 23 individual flour streams comprising the straight grade flour from each of the wheats were plotted on one graph (Fig. 2) to allow close comparison. The curves remained relatively flat (slow increase in ash) out to the range of total products yield with the

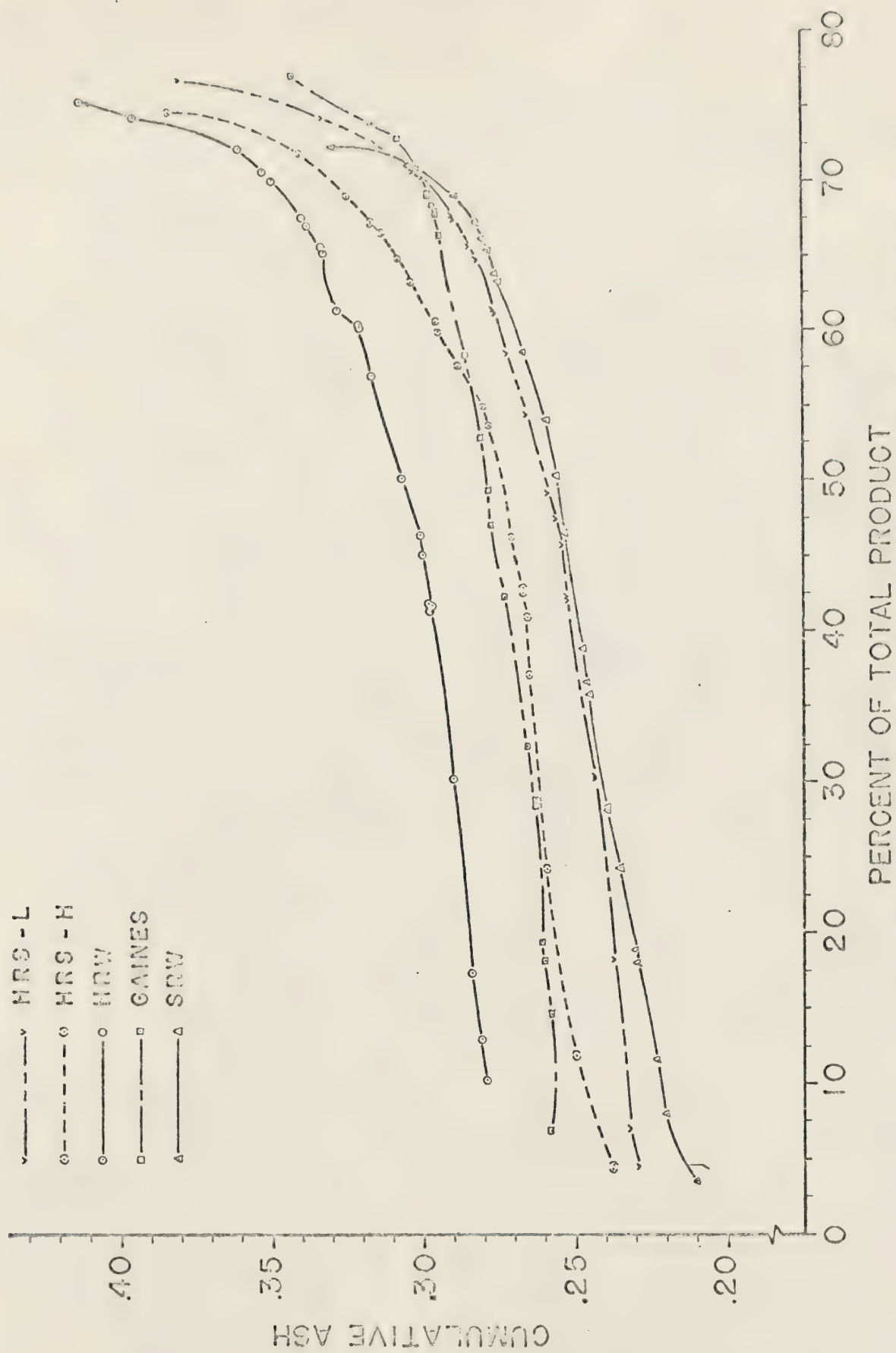


FIG. 2. Cumulative ash curves of all the component flow streams from each stream included in this study.

exception of H28-II. The curve of the H28-II flour turned upward too soon indicating a percent of total products yield. This was probably due to a combination of two factors. The kernels were small (Table 2, 41.5% over a 7 W and 22.9 grams per 1000 kernels) so the amount of available endosperm was reduced and the granulation curves indicate probable error in break roll adjustment. Though the rest of the curves were favorably shaped, they were well scattered with no apparent grouping of class or type (hard or soft).

The ash of the wheats (Table 2) and as the cumulative ash curves show, the ash of the various flours produced were appreciably different, one from another. Thus it would be impractical to compare the ash of an individual flour stream from each of the wheats. But since the flour streams are ordered according to ascending ash in computing cumulative ash (Appendix B) it is reasonable to compare the relative positions of an individual stream in the different wheat millings. Though the positions of the streams in the cumulative ash list are by no means constant, they do fix themselves in a general area on the list. The first and second midds streams and the siftings streams normally arrange themselves near the top of the list. Either first midds top or first midds bottom is usually lowest in ash. The bran and shorts duster flour was always the highest ash flour (bottom of the list) with fifth bran and sixth midds usually next above it. Most of the other streams have nearly the same positions in the list.

Several streams in the cumulative ash list for SEW were outside of their usual range of positions. The most noticeable is sixth midds flour, which is much higher in the list because it was lower in ash than normal.

The quantity (as percent of total products) of sixth middle flour was also above average (Fig. 11, and Table 14). This was due to the inefficient removal of the soft wheat flour as it was made earlier in the entire milling process. Since much of the flour made was not sifted through the flour cloths it continued to tail over and move toward the tail of the mill where it eventually ended up at sixth middle and thence in the red dog bag.

Some other streams which were out of their normal range of positions were fifth middle flour in the SW (it was high in the list and in quantity as was sixth middle flour, though not as radically so) and third middle flour in both the soft wheats was lower (higher in ash) in the list than usual. This is not easily explained since the material sent to third middle was no higher in ash than in other cases. First and second break flours were slightly higher in the list (lower in ash) in the soft wheats than normal when milling hard wheats. Second break of the SW was higher in the list and lower in ash than when any other wheats were milled.

Granulation curves showing particle size vs. percent of the system being plotted were graphed (Figs. 3, 4, 5, 6) for the first three breaks and the break dust section. The curves for first break (Fig. 3) show very little difference in granulation between the wheats except that HRS-H was considerably coarser (low break release) than the rest. This same trait followed that wheat in all the breaks. The seemingly under-adjusted breaks were probably responsible for the shape of the cumulative ash curve. HRS-H rose too rapidly at a relatively low percent of total products, as mentioned previously. On the first break after (Fig. 3) the SW was highest

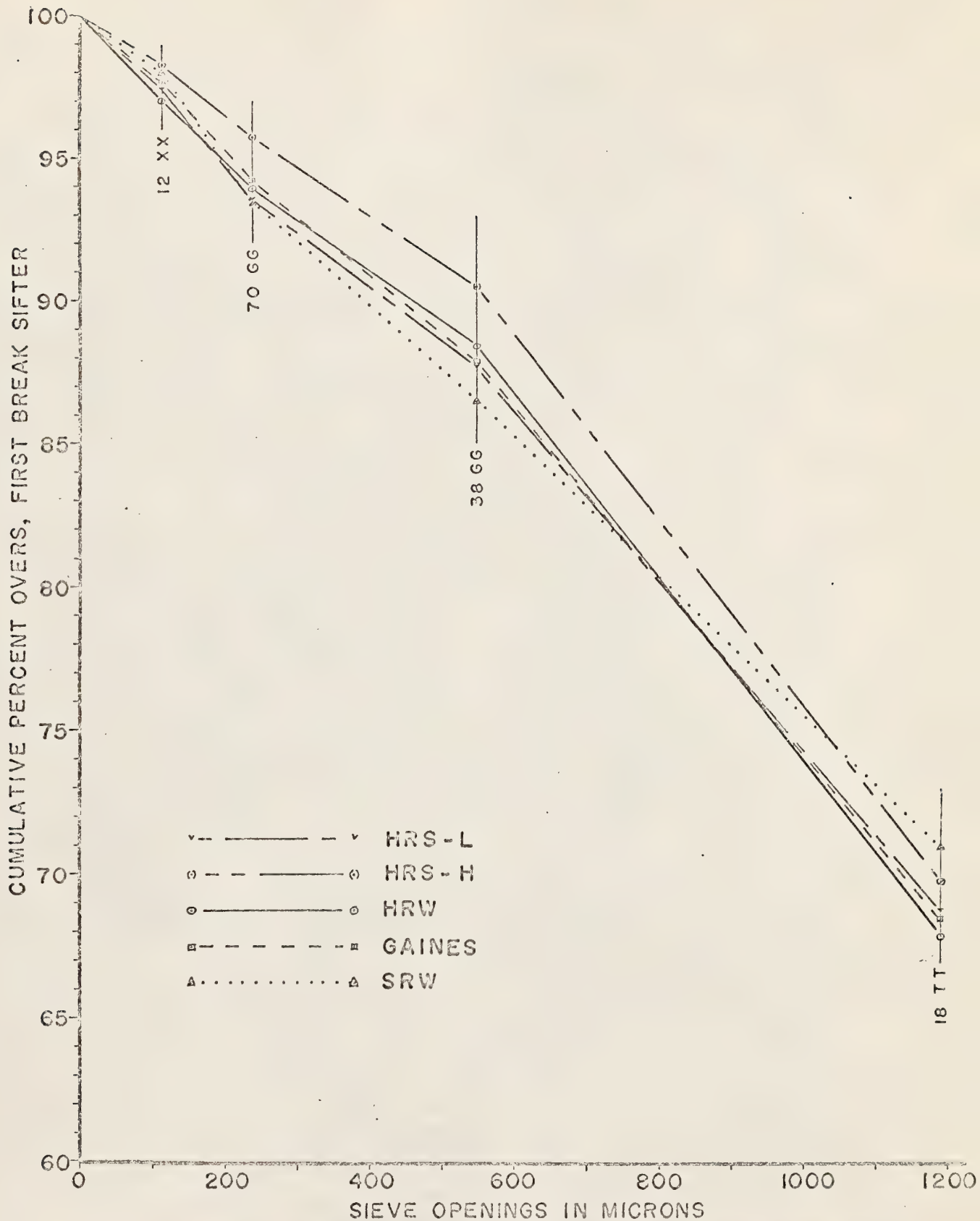


Fig. 3. Granulation curves of stock flowing from first break sifter.

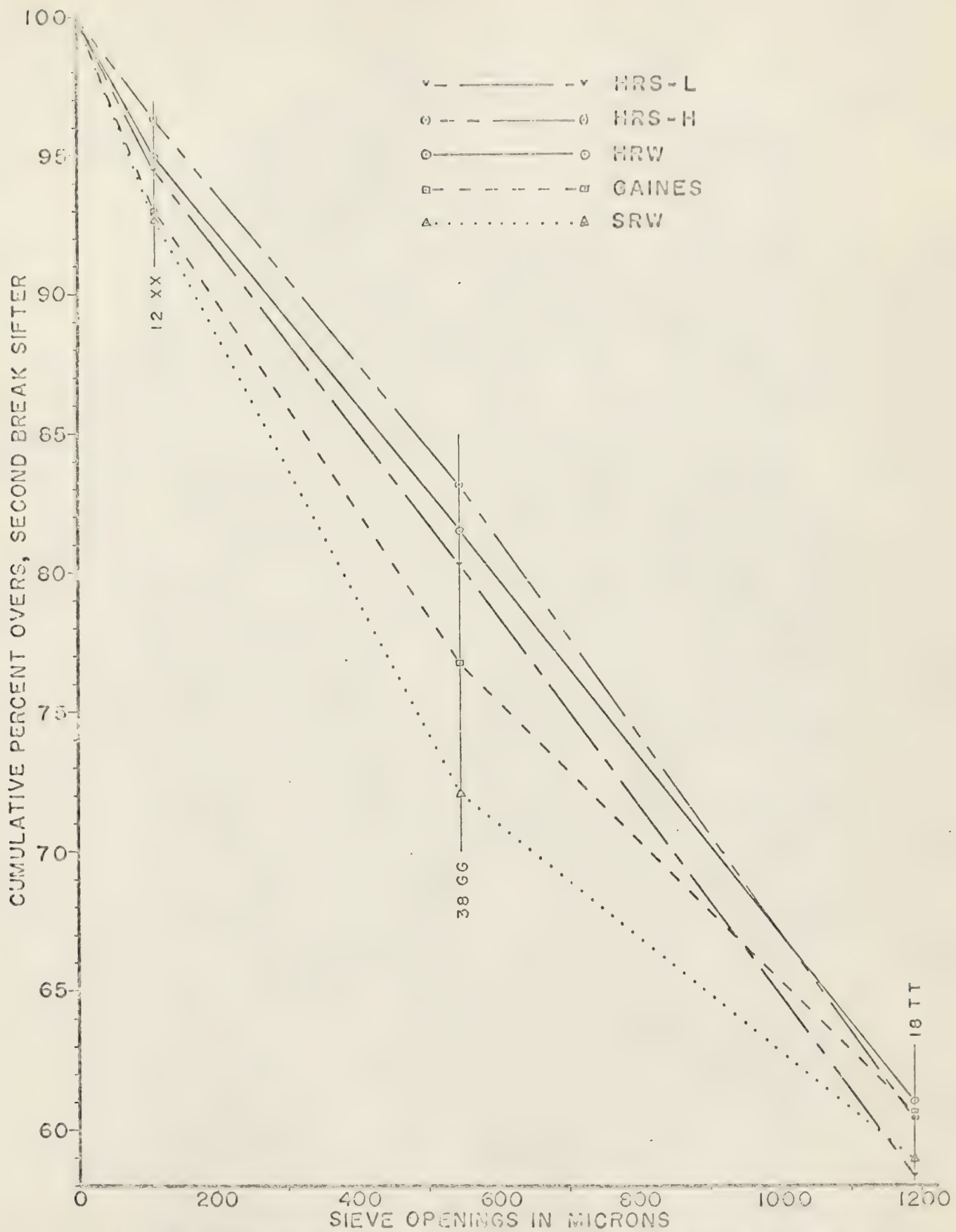


Fig. 4. Cumulative curves of stock flowing from second break sifter.

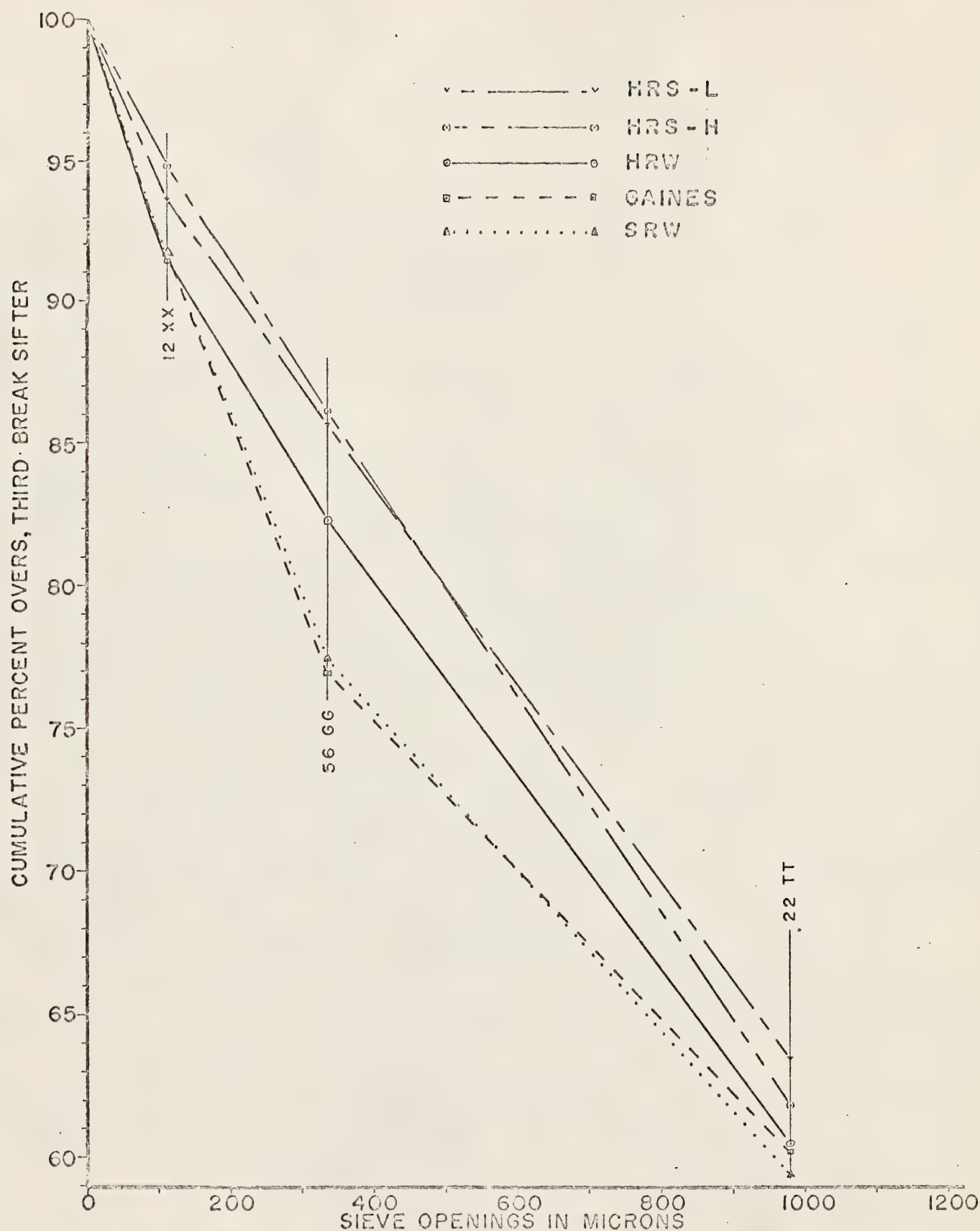


Fig. 5. Granulation curves of stock flowing from third break sifter.

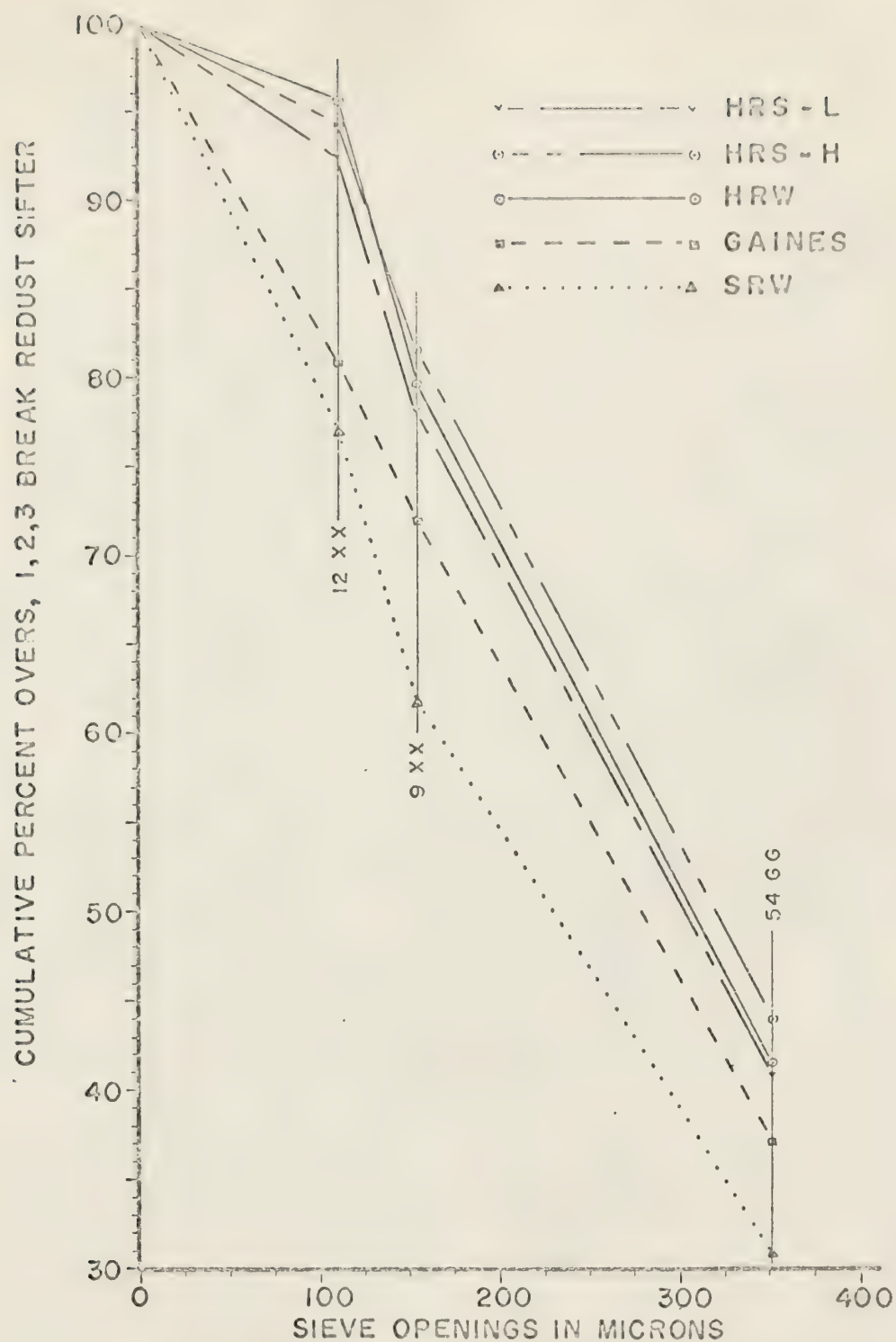


Fig. 6. Gradation curves of stock flowing from break redust sifter.

in percent over the 18tt (largest bran particles) and at the second sieve (38CS) it had the finest granulation in comparison to the other wheats. This indicates a relatively small amount over the 38CS as shown in Fig. 9 and Table 14. Comparing the total stock as percent of wheat (Tables 10, 11, 12, 13, 14) sent to P-1 during each milling, the data indicates that the soft wheats produced less coarse sizings than HRW. The spring wheats produced about the same or more coarse sizings than the HRW.

It was noticed that except for the HRS-H all the granulation curves of first break (Fig. 3) crossed the curve for SWW at about 800 to 825 microns size range. It was not determined in this study whether this was due to the relation of the milling sifter to the laboratory sifter used in adjusting bread releases or if it was simply caused by the differences in granulation. The importance of this graph (Fig. 3) was that there was little difference between the granulation of the classes of wheat. Also of importance was that they were not sufficiently different from a straight line approximation that mill balance might be affected by such an approximation.

The granulation curves of second and third breaks (Figs. 4, 5) show increasing differences in granulation between the classes of wheat. The soft wheats (SWW more than the Gaines) show the production of more fines than the hard wheats, with the spring wheats being the most coarse. This can be explained as the result of differences in the hardness of the endosperm of the various classes of wheat. The SWW, being the softest, reduced the fastest (making the most break flour), and the hard red spring wheats reduced the slowest.

The granulation curve of the break redust section would be expected to look like that for the hard wheats (straight, up to the flour cloth then leveling off sharply) since the flour should already have been removed. The concentration of stock passing over the 54gg and the 9m of the break redust section is also shown in the bar graph of the break redust section (Fig. 9). This was evidently not the case for the soft wheats (SNW yielding nearly six times as much break redust flour as the HW). The break flour removed in the break redust section of the soft wheat flows indicates incomplete sifting in the break sifters. That would account for the bowed shape of the soft wheat granulation curves for second and third breaks (Figs. 4, 5).

The granulation curves of the five breaks were plotted as a percent of the wheat sent to the mill (Figs. 7, 8). These curves seem to indicate the opposite of the granulation curves based on stream weight as a percent of the system. That is, in Figs. 7 and 8, there is more similarity between the granulation of the soft wheats and HW than between the two classes of hard wheats (HWS and HWS). It is suggested that the true granulation curves of the soft wheats are not represented by these curves (Figs. 3, 4, 5, 6, 7, 8). What is represented by the curve is the actual separation of the break sifters on the soft wheats, not what could have been separated.

The lowered efficiency of the break sifters on soft wheats is clearly evident in the granulation curves of second and third break (Fig. 8). The curves for the HW are straight, up to the flour cloth (11m, 110 microns), then it steps. This is because of the proportion of flour to the coarser particles. The same is true of the spring wheats (Fig. 7). But the increase

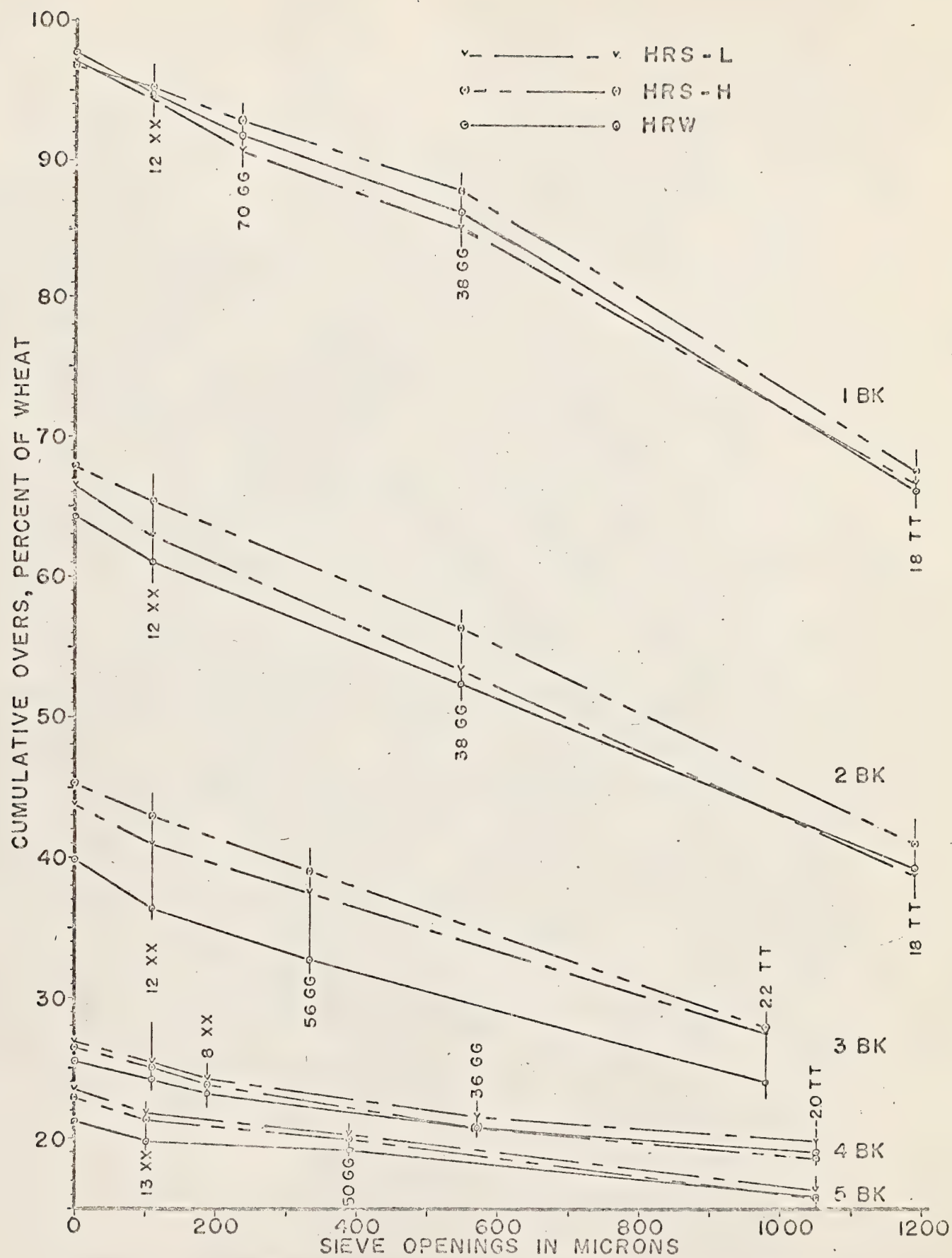


Fig. 7. Granulation curves of break stock as percent of wheat.

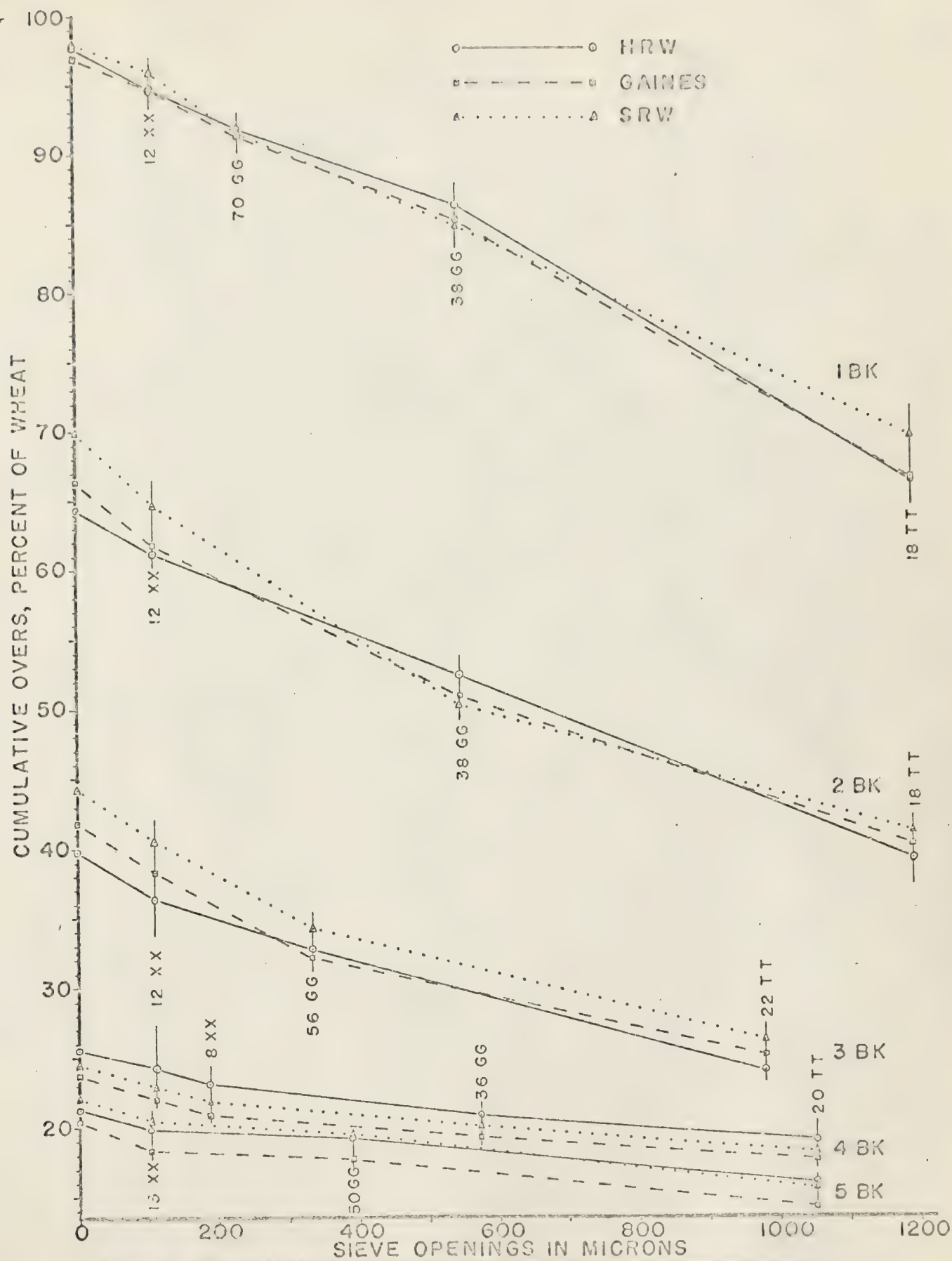


Fig. 1. Cumulative curves of back break at percent of wheat.

in steepness is less since the spring wheats are slightly harder to reduce and this made less break flour. The point of change in the slope of the soft wheat granulation curves came at the first sieve coarser than the flour cloth (second break- 3.55, 545 microns, and third break- 5.65, 333 microns). This was because the removal of the break flour was incomplete and the flour left had to tail over the flour cloth with the coarser particles. The soft wheat curves, as determined from the sifter sampling, are nearly parallel to the HW curve in flour production. They should, however, be much steeper since more break flour from soft wheat was available to be removed but was not completely removed.

Inspection of the bar graphs of the break redust section (Fig. 9) indicates that the break sifters were quite successful in removing the flour from the ground hard wheat stocks. The same graph also shows that the same sifters were quite inefficient in removing the flour produced by the breaks in the milling of soft wheats. Thus Figs. 7 and 8 represent only the actual sifting capability of the break sifters on soft wheat relative to that on HW.

In the case of the hard wheats, 60st HRS and HW, the granulation curves of the breaks (Figs. 7 and 8) do approach a straight line closely enough to permit such an approximation for the purpose of estimating flow rates in the design of new milling systems (18). This does not appear to be true however for the soft wheats. Had the break flour which was produced been removed by the respective break sifters with the same efficiency as the sifters showed on the hard wheats the break granulation curves would have been quite different for the soft wheats. They would

have been more concave than they were. The left hand half, the fine end of the curve, would have been steeper showing a greater increase in production of fines (break flour and fine middlings) compared to the hard wheats (42) than was indicated by the actual sifter separations. The right hand half of the curve would then have been flatter.

This being true, the straight line approximation of the granulation curve for soft wheats would not be satisfactory. A soft wheat flow or an actual system designed on such a basis would be under-designed to handle the fines and over-designed for handling the coarser break stock.

Cumulating the overs of the sieves as was done in plotting the granulation curves (Figs. 3, 4, 5, 6, 7, 8) sometimes tends to average out the actual differences in granulation. If for example the percent of stock over the first sieve in a stack of sieves is small and the percent over the second sieve is large. The cumulative percent of overs of the first and second sieves may then be on the average when actually each was quite different. For this reason bar graphs of the overs of each sieve were plotted (Figs. 9, 10, 11, 12) as a percent of the wheat sent to the mill.

Modulus of fineness and modulus of uniformity are two methods which are often used to describe the granulation characteristics of ground stock numerically. Modifications of these methods were used to compute numerical representations of the granulation of break stock (Tables 7, 9). These tables show very clearly that less sizings and more fine middlings and flour were produced by the softer wheats than by the hard wheats. Two graphs (Figs. 13, 14) plotted from the data of Tables 8 and 9 show the decrease in sizings production going from the HNS wheat through SNW wheat.

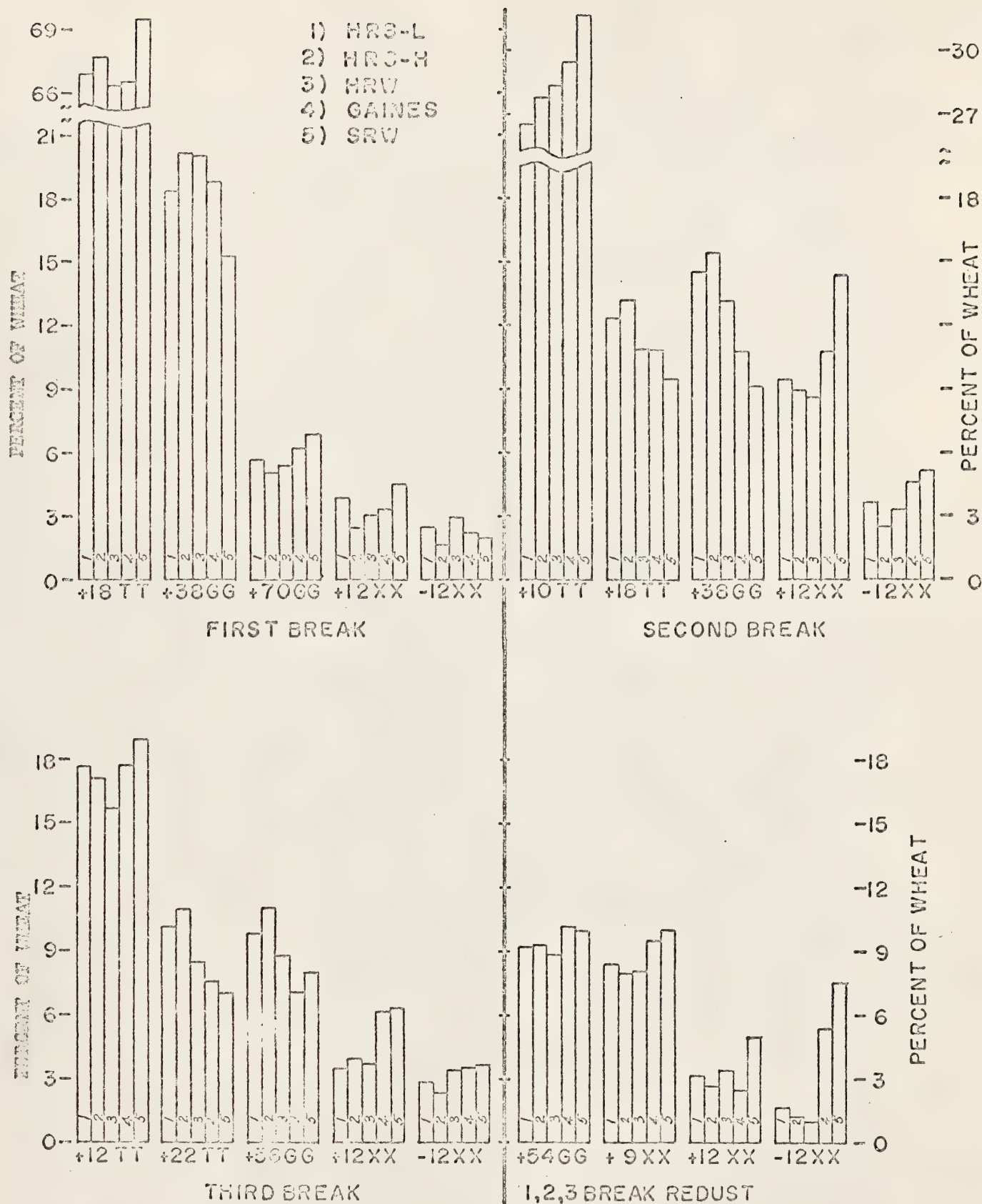


Fig. 2. Individual stream weights as a percent of the wheat to the mill.



Fig. 10. Individual roller weights as a percent of the wheat to the mill.

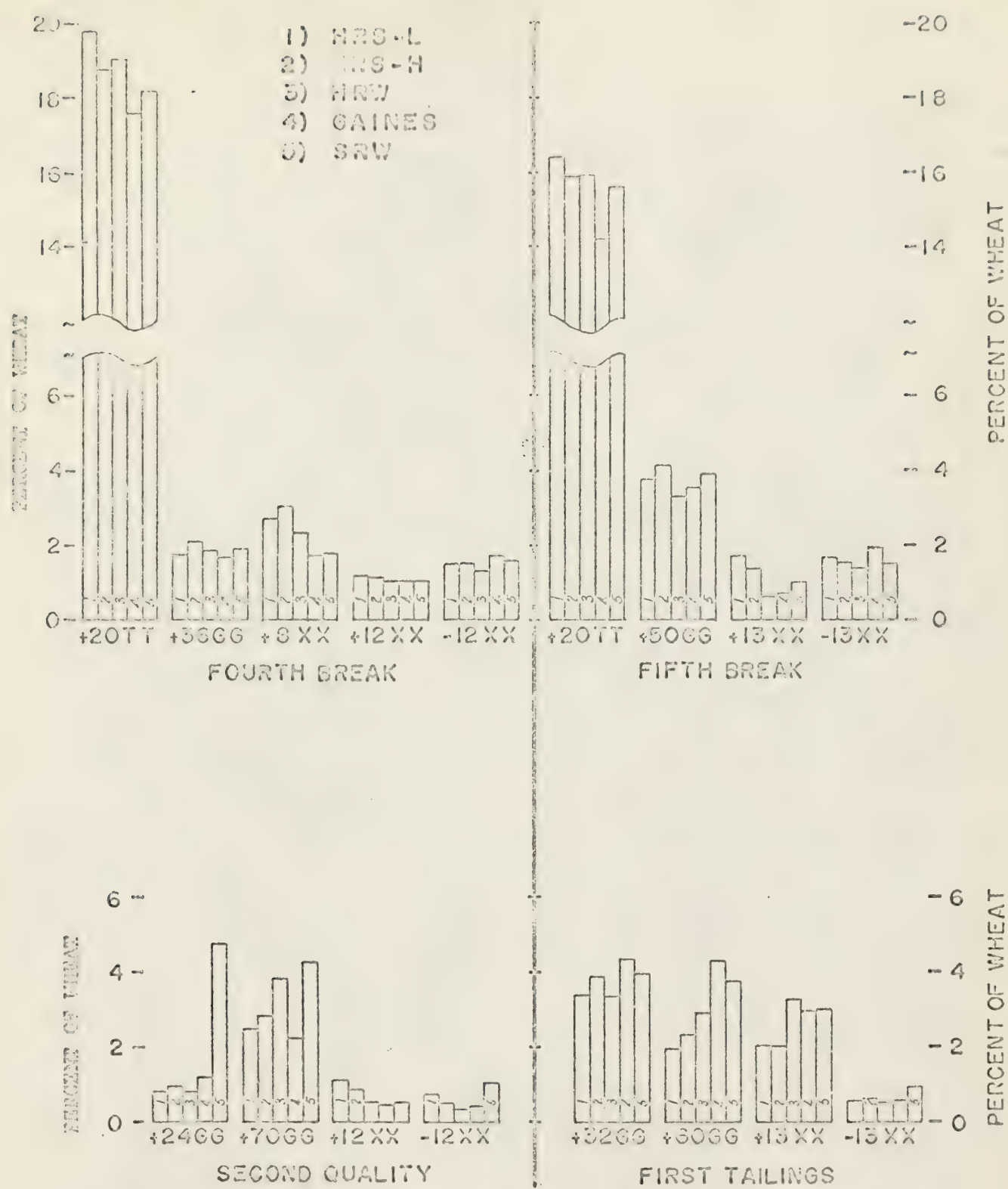


Fig. 12. Individual farm analysis of a percent of the wheat to the mill.

SIZINGS PRODUCTION FROM
THREE CLASSES OF WHEAT

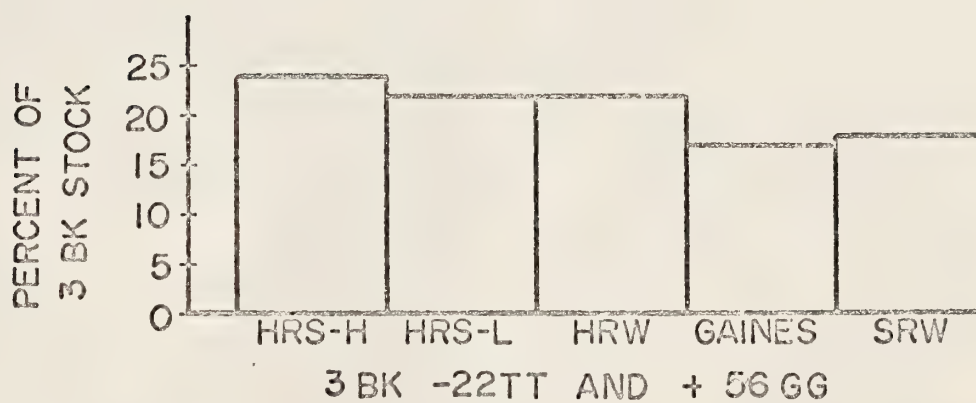
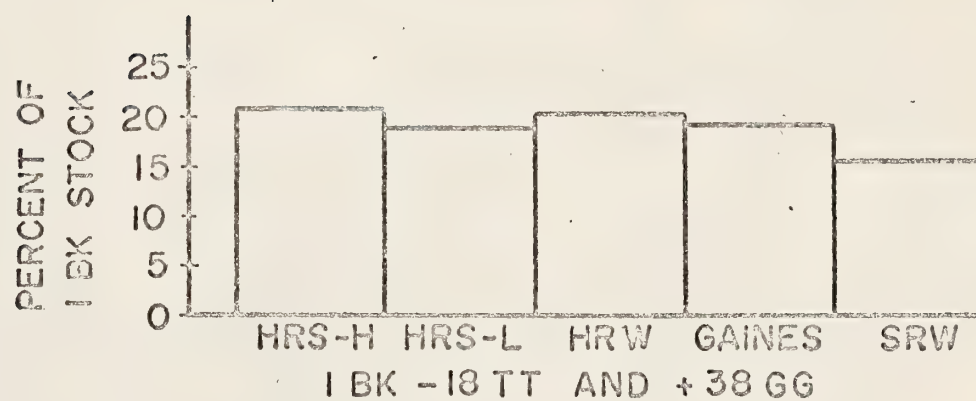


Fig. 13. Sizings production from three classes of wheat.

CUMULATIVE SIZINGS PRODUCTION FROM THREE CLASSES OF WHEAT

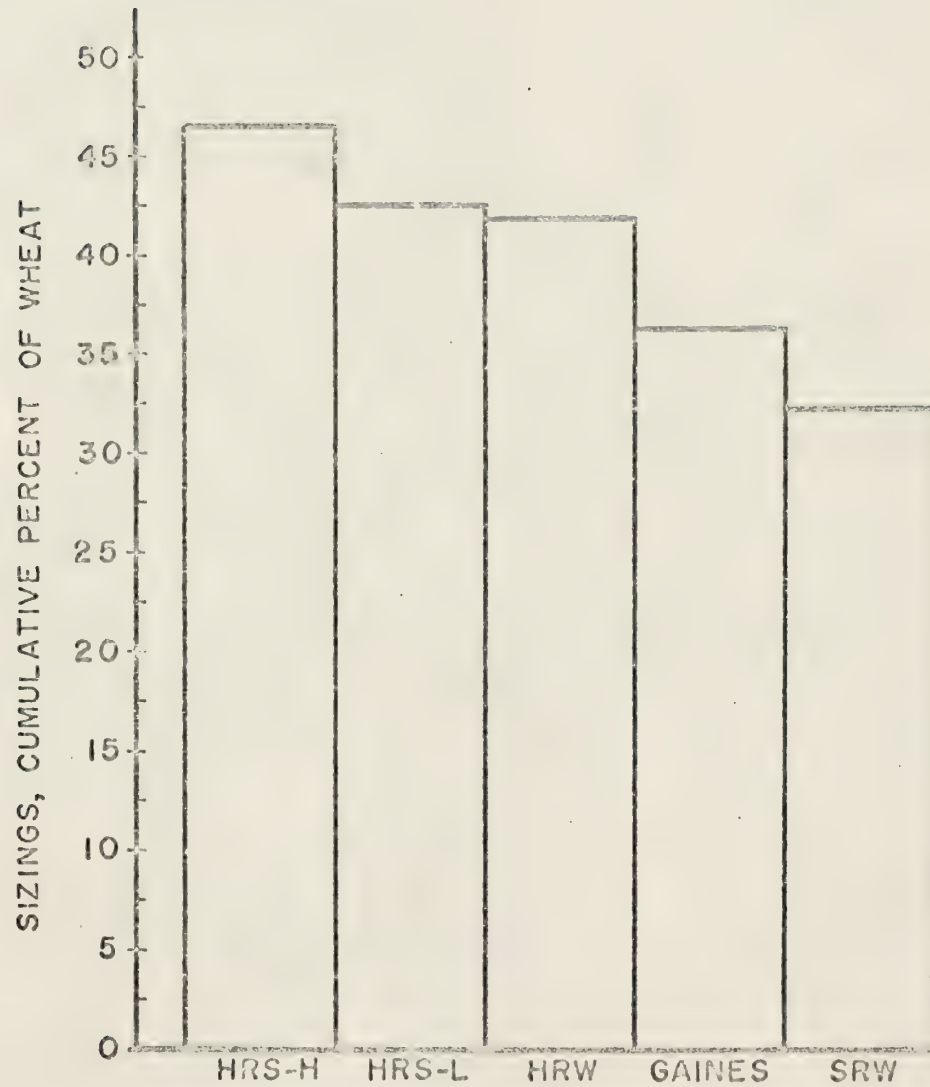


Fig. 14. Cumulative sizings production from three classes of wheat.

Table 7. Weights of fractions of break stocks.

Wheat	Break					
	1 Br.	2 Br.	3 Br.	4 Br.	5 Br.	
HRS-H	354.3	280.8	280.5	219.8	333.6	245.0
HRS-L	347.4	273.0	283.0	211.5	338.4	248.4
HRW	347.1	281.5	273.6	216.9	341.9	259.1
Gaines	346.3	274.8	271.1	189.9	336.5	247.4
SNW	348.8	269.0	272.0	169.5	339.0	252.6

Table 8. Break sizings (percent of wheat).

Break	Wheat				
	HRS-H	HRS-L	HRW	Gaines	SNW
1 Br. (-15WT +3000)	23.1	18.3	20.0	16.7	15.2
2 Br. (-15WT +3000)	15.4	14.6	13.2	10.6	9.1
3 Br. (-22WT +3000)	11.0	9.7	8.7	7.3	6.0
TOTALS	46.5	42.6	41.9	36.3	32.3

The quantity of sizings produced seems to be indicative of the relative ease of sifting. Ground stock from wheats which produce relatively large quantities of sizings (hard wheats) sifts more easily than stock from wheat which does not produce much sizings (soft wheat).

Tables 10, 11, 12, 13, and 14 were prepared as a check on the stream weights recorded during the sampling of the mill streams. The lines read horizontally indicate the loads as weighed leaving the section indicated on the left. The vertical columns indicate the loads which should be flowing to the section indicated at the top of the column.

Such tables are very useful in the design of a new flow to check against the existence of any "lean grounds" of stock. The systems are

Table 5. Modulus of uniformity of break stocks (% of stock from ciphers/10).

[illegible]

Table 14. S.R.V. FLOW RATES, % OF WHEAT, KANSAS STATE UNIVERSITY PIVOT FLOUR MILL

	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33	33-34	34-35	35-36	36-37	37-38	38-39	39-40	40-41	41-42	42-43	43-44	44-45	45-46	46-47	47-48	48-49	49-50	50-51	51-52	52-53	53-54	54-55	55-56	56-57	57-58	58-59	59-60	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-100	100-101	101-102	102-103	103-104	104-105	105-106	106-107	107-108	108-109	109-110	110-111	111-112	112-113	113-114	114-115	115-116	116-117	117-118	118-119	119-120	120-121	121-122	122-123	123-124	124-125	125-126	126-127	127-128	128-129	129-130	130-131	131-132	132-133	133-134	134-135	135-136	136-137	137-138	138-139	139-140	140-141	141-142	142-143	143-144	144-145	145-146	146-147	147-148	148-149	149-150	150-151	151-152	152-153	153-154	154-155	155-156	156-157	157-158	158-159	159-160	160-161	161-162	162-163	163-164	164-165	165-166	166-167	167-168	168-169	169-170	170-171	171-172	172-173	173-174	174-175	175-176	176-177	177-178	178-179	179-180	180-181	181-182	182-183	183-184	184-185	185-186	186-187	187-188	188-189	189-190	190-191	191-192	192-193	193-194	194-195	195-196	196-197	197-198	198-199	199-200	200-201	201-202	202-203	203-204	204-205	205-206	206-207	207-208	208-209	209-210	210-211	211-212	212-213	213-214	214-215	215-216	216-217	217-218	218-219	219-220	220-221	221-222	222-223	223-224	224-225	225-226	226-227	227-228	228-229	229-230	230-231	231-232	232-233	233-234	234-235	235-236	236-237	237-238	238-239	239-240	240-241	241-242	242-243	243-244	244-245	245-246	246-247	247-248	248-249	249-250	250-251	251-252	252-253	253-254	254-255	255-256	256-257	257-258	258-259	259-260	260-261	261-262	262-263	263-264	264-265	265-266	266-267	267-268	268-269	269-270	270-271	271-272	272-273	273-274	274-275	275-276	276-277	277-278	278-279	279-280	280-281	281-282	282-283	283-284	284-285	285-286	286-287	287-288	288-289	289-290	290-291	291-292	292-293	293-294	294-295	295-296	296-297	297-298	298-299	299-300	300-301	301-302	302-303	303-304	304-305	305-306	306-307	307-308	308-309	309-310	310-311	311-312	312-313	313-314	314-315	315-316	316-317	317-318	318-319	319-320	320-321	321-322	322-323	323-324	324-325	325-326	326-327	327-328	328-329	329-330	330-331	331-332	332-333	333-334	334-335	335-336	336-337	337-338	338-339	339-340	340-341	341-342	342-343	343-344	344-345	345-346	346-347	347-348	348-349	349-350	350-351	351-352	352-353	353-354	354-355	355-356	356-357	357-358	358-359	359-360	360-361	361-362	362-363	363-364	364-365	365-366	366-367	367-368	368-369	369-370	370-371	371-372	372-373	373-374	374-375	375-376	376-377	377-378	378-379	379-380	380-381	381-382	382-383	383-384	384-385	385-386	386-387	387-388	388-389	389-390	390-391	391-392	392-393	393-394	394-395	395-396	396-397	397-398	398-399	399-400	400-401	401-402	402-403	403-404	404-405	405-406	406-407	407-408	408-409	409-410	410-411	411-412	412-413	413-414	414-415	415-416	416-417	417-418	418-419	419-420	420-421	421-422	422-423	423-424	424-425	425-426	426-427	427-428	428-429	429-430	430-431	431-432	432-433	433-434	434-435	435-436	436-437	437-438	438-439	439-440	440-441	441-442	442-443	443-444	444-445	445-446	446-447	447-448	448-449	449-450	450-451	451-452	452-453	453-454	454-455	455-456	456-457	457-458	458-459	459-460	460-461	461-462	462-463	463-464	464-465	465-466	466-467	467-468	468-469	469-470	470-471	471-472	472-473	473-474	474-475	475-476	476-477	477-478	478-479	479-480	480-481	481-482	482-483	483-484	484-485	485-486	486-487	487-488	488-489	489-490	490-491	491-492	492-493	493-494	494-495	495-496	496-497	497-498	498-499	499-500	500-501	501-502	502-503	503-504	504-505	505-506	506-507	507-508	508-509	509-510	510-511	511-512	512-513	513-514	514-515	515-516	516-517	517-518	518-519	519-520	520-521	521-522	522-523	523-524	524-525	525-526	526-527	527-528	528-529	529-530	530-531	531-532	532-533	533-534	534-535	535-536	536-537	537-538	538-539	539-540	540-541	541-542	542-543	543-544	544-545	545-546	546-547	547-548	548-549	549-550	550-551	551-552	552-553	553-554	554-555	555-556	556-557	557-558	558-559	559-560	560-561	561-562	562-563	563-564	564-565	565-566	566-567	567-568	568-569	569-570	570-571	571-572	572-573	573-574	574-575	575-576	576-577	577-578	578-579	579-580	580-581	581-582	582-583	583-584	584-585	585-586	586-587	587-588	588-589	589-590	590-591	591-592	592-593	593-594	594-595	595-596	596-597	597-598	598-599	599-600	600-601	601-602	602-603	603-604	604-605	605-606	606-607	607-608	608-609	609-610	610-611	611-612	612-613	613-614	614-615	615-616	616-617	617-618	618-619	619-620	620-621	621-622	622-623	623-624	624-625	625-626	626-627	627-628	628-629	629-630	630-631	631-632	632-633	633-634	634-635	635-636	636-637	637-638	638-639	639-640	640-641	641-642	642-643	643-644	644-645	645-646	646-647	647-648	648-649	649-650	650-651	651-652	652-653	653-654	654-655	655-656	656-657	657-658	658-659	659-660	660-661	661-662	662-663	663-664	664-665	665-666	666-667	667-668	668-669	669-670	670-671	671-672	672-673	673-674	674-675	675-676	676-677	677-678	678-679	679-680	680-681	681-682	682-683	683-684	684-685	685-686	686-687	687-688	688-689	689-690	690-691	691-692	692-693	693-694	694-695	695-696	696-697	697-698	698-699	699-700	700-701	701-702	702-703	703-704	704-705	705-706	706-707	707-708	708-709	709-710	710-711	711-712	712-713	713-714	714-715	715-716	716-717	717-718	718-719	719-720	720-721	721-722	722-723	723-724	724-725	725-726	726-727	727-728	728-729	729-730	730-731	731-732	732-733	733-734	734-735	735-736	736-737	737-738	738-739	739-740	740-741	741-742	742-743	743-744	744-745	745-746	746-747	747-748	748-749	749-750	750-751	751-752	752-753	753-754	754-755	755-756	756-757	757-758	758-759	759-760	760-761	761-762	762-763	763-764	764-765	765-766	766-767	767-768	768-769	769-770	770-771	771-772	772-773	773-774	774-775	775-776	776-777	777-778	778-779	779-780	780-781	781-782	782-783	783-784	784-785	785-786	786-787	787-788	788-789	789-790	790-791	791-792	792-793	793-794	794-795	795-796	796-797	797-798	798-799	799-800	800-801	801-802	802-803	803-804	804-805	805-806	806-807	807-808	808-809	809-810	810-811	811-812	812-813	813-814	814-815	815-816	816-817	817-818	818-819	819-820	820-821	821-822	822-823	823-824	824-825	825-826	826-827	827-828	828-829	829-830	830-831	831-832	832-833	833-834	834-835	835-836	836-837	837-838	838-839	839-840	840-841	841-842	842-843	843-844	844-845	845-846	846-847	847-848	848-849	849-850	850-851	851-852	852-853	853-854	854-855	855-856	856-857	857-858	858-859	859-860	860-861	861-862	862-863	863-864	864-865	865-866	866-867	867-868	868-869	869-870	870-871	871-872	872-873	873-874	874-875	875-876	876-877	877-878	878-879	879-880	880-881	881-882	882-883	883-884	884-885	885-886	886-887	887-888	888-889	889-890	890-891	891-892	892-893	893-894	894-895	895-896	896-897	897-898	898-899	899-900	900-901	901-902	902-903	903-904	904-905	905-906	906-907	907-908	908-909	909-910	910-911	911-912	912-913	913-914	914-915	915-916	916-917	917-918	918-919	919-920	920-921	921-922	922-923	923-924	924-925	925-926	926-927	927-928	928-929	929-930	930-931	931-932	932-933	933-934	934-935	935-936	936-937	937-938	938-939	939-940	940-941	941-942	942-943	943-944	944-945	945-946	946-947	947-948	948-949	949-950	950-951	951-952	952-953	953-954	954-955	955-956	956-957	957-958	958-959	959-960	960-961	961-962	962-963	963-964	964-965	965-966	966-967	967-968	968-969	969-970	970-971	971-972	972-973	973-974	974-975	975-976	976-977	977-978	978-979	979-980	980-981	981-982	982-983	983-984	984-985	985-986	986-987	987-988	988-989	989-990	990-991	991-992	992-993	993-994	994-995	995-996	996-997	997-998	998-999	999-1000	1000-1001	1001-1002	1002-1003	1003-1004	1004-1005	1005-1006	1006-1007	1007-1008	1008-1009	1009-1010	1010-1011	1011-1012	1012-1013	1013-1014	1014-1015	1015-1016	1016-1017	1017-1018	1018-1019	1019-1020	1020-1021	1021-1022	1022-1023	1023-1024	1024-1025	1025-1026	1026-1027	1027-1028	1028-1029	1029-1030	1030-1031	1031-1032	1032-1033	1033-1034	1
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arranged from head to tail of the mill going down the page and also from left to right across the page. In this way any entry below the heavy diagonal line must be going to a section which is ahead (in the line of flow) of the one from which it came. This is undesirable since the same stock must be "run around" in that cycle until it is reduced sufficiently to pass through a finer sieve and get out of the loop. All the time there may be a cumulative build-up of the quantity of stock sent to the head of the "run around." This often would mean the reduction in size of some branny (high ash) material, which is contrary to the object of the milling process.

The Tables 10, 11, 12, 13 and 14 are in percent of the wheat sent to the mill. Thus they give a quick check on the balance of the mill in one weigh-up as compared to another.

Flour production data from 14 weigh-ups on six hard red winter wheats is given in Appendix C. From this data the mean and the standard deviation from the mean of flour production of each stream were computed (Table 15). The flour stream weights from any single wheat were fairly constant from one sampling to the next. But from one wheat to another the variation in the flour stream weights increased considerably as shown by the deviations from the means (Table 15).

Using these mean flour weights, a reasonable comparison of total break and duster flour produced was possible (Table 16). This comparison again points out the previously noted fact that the break adjustment was off during the HRS-M milling. Also the greatly increased break flour production (Gaines was 26% and S&M was 46% greater than the mean for HRS)

Table 15. Mean individual flour stream weights.

Flour stream	Mean stream wt. % T.P.	Standard deviation from mean
Pre Bk	.131	.000
1 Bk	2.422	.271
2 Bk	3.869	.465
3 Bk	3.739	.233
1,2,3 Red	2.173	.476
C Siz T	1.849	.393
C Siz B	.108	.032
F Siz T	2.959	1.233
F Siz B	.343	.237
1 Mids T	8.318	1.722
1 Mids B	3.914	.893
2 Mids T	11.480	1.521
2 Mids B	3.123	.413
2 Qual	.693	.153
4 Bk	1.402	.185
3 Mids	10.031	1.603
1 Tails	.818	.182
4 Mids	6.473	1.108
Suction	.300	.116
5 Bk	1.501	.263
5 Mids	4.162	.753
B and SD	2.475	.271
6 Mids	2.304	.286

Table 16. Break flour produced.

Stream	HNW mean	Percent of total products			
		HRS-L	HRS-H	Gaines	SNW
P-Bk	.13	.15	.05	.18	.09
1 Bk	2.42	2.74	1.77	2.33	2.13
2 Bk	3.87	4.11	2.60	4.75	5.42
3 Bk	3.74	3.26	2.44	3.47	3.82
Bk red.	2.18	1.67	1.26	5.50	7.64
4 Bk	1.40	1.83	1.57	1.32	1.56
5 Bk	1.50	1.89	1.60	1.98	1.75
PS&D	2.48	2.45	2.85	3.15	3.34
TOTAL	17.72	18.20	14.14	22.73	25.81

in soft wheat milling was due mainly to increased flour made by the first three breaks and not from the cleanup breaks (fourth and fifth breaks) (35).

The relative quantities of flour, bran, shorts, red dog and germ for each wheat milled are given in Table 17. Extensive physical and chemical analysis of each mill feed have been published (11, 43).

SUMMARY

The data collected during this study gave an indication of the differences and similarities of the distribution of stock produced when milling wheats from four different classes (HRW, HRS, SRW, and Western White). The data showed the similarity of the milling characteristics of the HRS wheats and those of HRW wheat. Though the granulation of the break stocks from the HRS wheats was coarser than those from the HRW wheats, the sifting characteristics appeared to be quite similar. All through the mill the soft wheats (both SRW and the Western White) were quite different from the hard wheats. The soft wheats produced much more fine break stock than any of the hard wheats and the ground soft wheat sifted more slowly than those from the hard wheats.

The break granulation curves produced from the streams as weighed flowing from the break sifters indicated that a straight line approximation of the granulation of break stock produced from hard wheats would be satisfactory for flow sheet and mill designing purposes. The second and third break granulation curves of the break stock from the soft wheats were much more concave than the similar curves of hard wheat break stock. This indicates an increased production of fine middlings and flour when

Table 17. Percentages of the products of milling.

Wheat	WMM-L	WMM-M	WMM-1	WMM-2	WMM-3	WRS-1	WRS-E	Colnec	SWW
	% T.P.	% T.P.	% T.P.	% T.P.	% T.P.	% T.P.	% T.P.	% T.P.	% T.P.
Flour	72.98	72.44	74.57	75.92	74.95	76.73	74.68	77.03	72.33
Bran	16.66	13.80	14.26	15.31	13.82	13.82	14.68	12.52	14.21
Shorts	6.94	8.87	7.07	6.60	7.79	6.80	7.93	7.83	8.00
Red Dog	2.53	3.66	3.35	1.39	2.57	1.80	1.64	1.67	4.69
Germ	0.69	0.58	0.75	0.88	0.87	0.85	1.06	0.95	0.77
Choke		0.67 ¹							
Total feed	27.02	27.58	25.43	24.18	25.05	23.27	25.31	22.97	27.67
Total products	100.00	100.02	100.00	100.00	100.00	100.00	99.99	100.00	100.00

¹This was 64 pounds of fifth brock stock, more like feed than flour, collected following a choke of the fifth brock pneumatic mill.

milling soft wheats. The granulation curves of stock flowing from the break redust sifter show the incomplete sifting of soft wheat break stock in the break sifters. This also indicates that the break granulation curves from the soft wheat millings should have been more concave than they were.

The distribution of stock in the reduction system of the mill for the hard and soft wheats was quite dissimilar. The soft wheats reduced more quickly but sifted more slowly than the hard wheats. This caused the load on the tail of the mill to be high and the tail end ash to be lower during the soft wheat milling than during the hard wheat milling. The HRS wheat showed some tendency to be more difficult to reduce than the HRW wheat but sifted with the same ease as HRW.

The weigh-ups of individual flour streams during the millings of the HRW wheats showed that individual stream weights remained fairly constant during the milling of a given wheat. Between wheats (only one wheat was milled on any day) there was somewhat greater difference in individual stream weights.

SUGGESTIONS FOR FUTURE WORK

The data acquired during this study represent a base to build on and add to in the acquisition of knowledge which will be required before a flour mill is finally automated. Future studies on the same mill could investigate the feasibility of adjusting the milling machinery based on the mean individual flow stream weights presented in the present study. The flow protocol during each grinding operation serves a likely basis

for controlling a flour mill since flour production is common to every grinding and sifting operation in a mill, purification excluded.

A series of granulation curves obtained from different roll settings of the same pair of rolls grinding the same stock could give some insight as to the portion of the ground stock which would best reflect the performance of the given set of rolls. This would be of interest in studying the control of a flour mill by sensing the rate of flour production.

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APPENDIX

APPENDIX A

STRENGTH AND ANALYSIS OF ALL THE STRENGTH
IN THE E.S.E. HOUSE FLOOR BEAM

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** P BK HRS-L ****								
+24TT 1 BK	1071.0	98.76	98.76	98.76	98.76	1.51	11.14	14.3
+38GG P-1	5.0	.46	99.22	.46	99.22	.82	9.82	14.2
+70GG B-RD	4.0	.37	99.59	.37	99.59	.45	8.75	14.5
+12XX B RD	3.0	.28	99.86	.28	99.86	.37	8.27	14.7
-12XX FL	1.5	.14	100.00	.14	100.00	.37	9.47	14.6
**** P BK HRS-H ****								
+24TT 1 BK	1055.0	99.37	99.37	99.37	99.37	1.52	13.72	15.4
+38GG P-1	3.5	.33	99.70	.33	99.70	1.19	13.09	13.3
+70GG B-RD	2.4	.23	99.92	.23	99.92	.76	11.80	13.3
+12XX B RD	.3	.03	99.95	.03	99.95	.94	10.28	11.3
-12XX FL	.5	.05	100.00	.05	100.00	.62	13.02	14.1
**** P BK GAINES ****								
+24TT 1 BK	859.0	98.13	98.13	98.13	98.13	1.19	9.66	13.6
+38GG P-1	8.5	.97	99.10	.97	99.10	.78	9.24	13.4
+70GG B RD	4.7	.54	99.63	.54	99.63	.46	7.50	12.8
+12XX B RD	1.6	.18	99.82	.18	99.82	.41	7.42	13.1
-12XX FL	1.6	.18	100.00	.18	100.00	.45	6.52	14.2
**** P BK SRW ****								
+24TT 1 BK	944.0	99.13	99.13	99.13	99.13	1.62	12.03	14.9
+38GG P-1	2.5	.26	99.39	.26	99.39	.49	8.94	14.4
+70GG B RD	2.0	.21	99.60	.21	99.60	.36	9.20	14.0
+12XX B RD	3.0	.32	99.92	.32	99.92	.45	9.73	13.4
-12XX FL	.8	.08	100.00	.08	100.00	.40	9.26	14.6
**** P BK HRW ****								
+24TT 1 BK	1079.0	98.72	98.72	98.72	98.72	1.52	12.40	15.4
+38GG P-1	6.0	.55	99.27	.55	99.27	.52	9.89	14.8
+70GG B RD	3.0	.27	99.54	.27	99.54	.35	9.67	14.6
+12XX B RD	3.0	.27	99.82	.27	99.82	.38	8.78	13.8
-12XX FL	2.0	.18	100.00	.18	100.00	.40	9.74	13.5

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** I BK	HRS-L ****							
+18TT 2 BK	724.0	68.79	68.79	66.76	66.76	1.90	11.70	14.0
+38GG P-1	199.0	18.91	87.70	18.35	85.11	.60	9.92	15.0
+70GG B RD	61.0	5.80	93.49	5.62	90.73	.36	8.78	15.8
+12XX B RD	41.5	3.94	97.43	3.83	94.56	.35	8.76	15.6
-12XX FL	27.0	2.57	100.00	2.49	97.05	.37	10.08	15.5
**** I BK	HRS-H ****							
+18TT 2 BK	718.4	69.77	69.77	67.67	67.67	2.09	14.43	13.6
+38GG P-1	213.8	20.77	90.54	20.14	87.80	.65	11.43	14.2
+70GG B RD	53.6	5.21	95.75	5.05	92.85	.39	11.61	14.8
+12XX B RD	25.8	2.51	98.25	2.43	95.28	.39	12.69	14.6
-12XX FL	18.0	1.75	100.00	1.70	96.98	.49	14.94	14.8
**** I BK	GAINES ****							
+18TT 2 BK	582.0	68.54	68.54	66.48	66.48	1.58	10.84	12.7
+38GG P-1	164.0	19.31	87.85	18.73	85.22	.46	7.77	13.7
+70GG B RD	54.4	6.41	94.25	6.21	91.43	.30	7.37	13.7
+12XX B RD	29.1	3.43	97.68	3.32	94.76	.30	7.79	13.9
-12XX FL	19.7	2.32	100.00	2.25	97.01	.31	5.61	14.1
**** I BK	SRW ****							
+18TT 2 BK	662.0	70.95	70.95	69.52	69.52	2.29	13.44	13.6
+38GG P-1	145.0	15.54	86.50	15.23	84.74	.52	9.88	14.7
+70GG B RD	65.0	6.97	93.46	6.83	91.57	.29	9.60	14.9
+12XX B RD	42.0	4.50	97.96	4.41	95.98	.26	9.92	15.0
-12XX FL	19.0	2.04	100.00	2.00	97.97	.27	6.58	15.1
**** I BK	HRW ****							
+18TT 2 BK	725.0	67.88	67.88	66.33	66.33	2.05	13.24	16.2
+38GG P-1	219.0	20.51	88.39	20.04	86.37	.52	9.96	15.4
+70GG B RD	59.0	5.52	93.91	5.40	91.77	.37	9.56	15.4
+12XX B RD	33.0	3.09	97.00	3.02	94.78	.39	10.12	15.9
-12XX FL	32.0	3.00	100.00	2.93	97.71	.40	11.09	15.5

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** 2 BK HRS-L ***								
+10TT 3 BC	288.0	39.89	39.89	26.56	26.56	3.09	12.47	13.8
+18TT 3 BF	133.5	18.49	58.38	12.31	38.87	2.70	13.38	13.9
+38GG P-1	158.0	21.88	80.26	14.57	53.43	.77	10.72	14.2
+12XX B RD	102.5	14.20	94.46	9.45	62.89	.31	9.91	15.8
-12XX FL	40.0	5.54	100.00	3.69	66.57	.35	10.46	15.3
*** 2 BK HRS-H ***								
+10TT 3 BC	295.0	40.91	40.91	27.79	27.79	3.18	15.81	13.5
+18TT 3 BF	140.9	19.54	60.45	13.27	41.06	2.70	15.60	14.0
+38GG P-1	163.5	22.67	83.12	15.40	56.46	.90	12.79	14.6
+12XX B RD	95.2	13.20	96.33	8.97	65.42	.34	13.05	15.0
-12XX FL	26.5	3.67	100.00	2.50	67.92	.45	12.10	14.7
*** 2 BK GAINES ***								
+10TT 3 BC	258.0	44.41	44.41	29.47	29.47	2.26	12.08	12.4
+18TT 3 BF	94.6	16.28	60.69	10.81	40.28	2.07	12.51	12.7
+38GG P-1	93.2	16.04	76.73	10.65	50.93	.73	9.17	11.8
+12XX B RD	94.5	16.27	92.99	10.80	61.72	.31	8.47	13.7
-12XX FL	40.7	7.01	100.00	4.65	66.37	.30	6.60	14.0
*** 2 BK SRW ***								
+10TT 3 BC	302.0	45.41	45.41	31.71	31.71	3.53	14.42	12.3
+18TT 3 BF	90.0	13.53	58.95	9.45	41.16	3.22	15.59	14.5
+38GG P-1	87.0	13.08	72.03	9.14	50.30	.96	12.43	14.2
+12XX B RD	137.0	20.60	92.63	14.39	64.69	.28	11.35	15.1
-12XX FL	49.0	7.37	100.00	5.15	69.83	.27	7.90	15.1
*** 2 BK HRW ***								
+10TT 3 BC	310.0	44.10	44.10	28.36	28.36	2.95	14.74	15.4
+18TT 3 BF	119.0	16.93	61.02	10.89	39.25	2.75	15.06	15.5
+38GG P-1	144.0	20.48	81.51	13.17	52.42	.76	10.89	15.0
+12XX B RD	94.0	13.37	94.88	8.60	61.02	.32	10.93	15.5
-12XX FL	36.0	5.12	100.00	3.29	64.32	.39	11.69	15.4

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** P-1	HRS-L	****						
ASP SUC	1.6	.42	.42	.15	.15	2.56	11.34	12.8
+20GG 3 BF	51.6	13.63	14.05	4.76	4.91	1.99	12.56	13.7
+24GG C.S.	37.8	9.98	24.03	3.49	8.39	1.11	11.97	14.5
-24GG C.S.	196.0	51.76	75.79	18.07	26.46	.44	9.89	14.8
-32GG F.S.	91.7	24.21	100.00	8.46	34.92	.31	9.78	15.6
**** P-1 9	HRS-H	****						
ASP SUC	1.4	.36	.36	.13	.13	3.53	13.84	12.4
+20GG 3 BF	54.4	13.98	14.34	5.12	5.26	2.06	13.92	12.3
+24GG C.S.	46.1	11.85	26.20	4.34	9.60	.96	12.19	13.2
-24GG C.S.	200.0	51.41	77.61	18.84	28.44	.50	11.53	14.2
-32GG F.S.	87.1	22.39	100.00	8.20	36.64	.30	11.91	14.8
**** P-1	GAINES	****						
ASP 5 BK	.4	.15	.15	.05	.05	2.41	9.06	10.8
+20GG 3 BF	28.0	10.66	10.81	3.20	3.24	1.67	11.51	12.6
+24GG C.S.	30.0	11.42	22.23	3.43	6.67	.87	9.79	13.9
-24GG C.S.	131.5	50.06	72.29	15.02	21.69	.51	8.17	13.7
-32GG F.S.	72.8	27.71	100.00	8.32	30.01	.31	7.61	14.1
**** P-1	SRW	****						
ASP 5 BK	1.1	.47	.47	.12	.12	1.39	8.35	13.5
+20GG 3 BF	34.4	14.73	15.20	3.61	3.73	2.00	12.23	14.2
+24GG C.S.	21.0	8.99	24.20	2.21	5.93	1.20	12.34	14.3
-24GG C.S.	111.0	47.54	71.73	11.66	17.59	.61	10.32	14.2
-32GG F.S.	66.0	28.27	100.00	6.93	24.52	.28	10.60	14.8
**** P-1	HRW	****						
ASP 5 BK	.1	.04	.04	.01	.01	2.71	9.70	11.3
+20GG 3 BF	33.0	8.99	9.02	3.02	3.03	2.09	13.25	13.7
+24GG C.S.	47.0	12.80	21.83	4.30	7.33	1.11	11.42	14.9
-24GG C.S.	210.0	57.20	79.03	19.21	26.54	.57	10.12	15.0
-32GG F.S.	77.0	20.97	100.00	7.04	33.59	.32	9.87	12.9

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** 3 BK HRS-L ***								
+12TT 4 BC	191.0	40.25	40.25	17.61	17.61	4.17	12.30	13.3
+22TT 4 BF	110.0	23.18	63.44	10.14	27.75	3.88	14.42	13.5
+56GG P-4	105.5	22.23	85.67	9.73	37.48	.96	11.25	14.4
+12XX B RD	38.0	8.01	93.68	3.50	40.99	.25	10.94	15.1
-12XX FL	30.0	6.32	100.00	2.77	43.75	.38	11.90	14.7
*** 3 BK HRS-H ***								
+12TT 4 BC	181.3	37.70	37.70	17.08	17.08	4.50	15.54	12.0
+22TT 4 BF	116.0	24.12	61.82	10.93	28.00	3.84	17.53	12.7
+56GG P-4	116.9	24.31	86.13	11.01	39.01	1.10	13.93	14.2
+12XX B RD	41.8	8.69	94.82	3.94	42.95	.40	14.69	14.5
-12XX FL	24.9	5.18	100.00	2.35	45.30	.45	11.67	14.5
*** 3 BK GAINES ***								
+12TT 4 BC	154.5	42.19	42.19	17.65	17.65	3.19	13.03	10.9
+22TT 4 BF	66.0	18.02	60.21	7.54	25.19	3.20	13.40	11.4
+56GG P-4	61.4	16.77	76.98	7.01	32.20	1.48	12.22	12.7
+12XX B RD	53.8	14.69	91.67	6.15	38.35	.37	10.18	13.0
-12XX FL	30.5	8.33	100.00	3.48	41.83	.33	7.61	14.1
*** 3 BK SRW ***								
+12TT 4 BC	183.0	43.47	43.47	19.22	19.22	4.97	14.72	11.8
+22TT 4 BF	67.0	15.91	59.38	7.04	26.25	4.64	16.09	12.9
+56GG P-4	76.0	18.05	77.43	7.98	34.23	1.90	14.47	13.8
+12XX B RD	60.0	14.25	91.69	6.30	40.53	.40	14.05	14.9
-12XX FL	35.0	8.31	100.00	3.68	44.21	.30	9.90	14.9
*** 3 BK HRW ***								
+12XX 4 BC	171.0	39.31	39.31	15.65	15.65	4.17	15.55	15.4
+22XX 4 BF	92.0	21.15	60.46	8.42	24.06	4.00	16.10	14.0
+56GG P-4	95.0	21.84	82.30	8.69	32.75	1.22	12.76	15.1
+12XX B RD	40.0	9.20	91.49	3.66	36.41	.42	12.46	14.4
-12XX FL	37.0	8.51	100.00	3.39	39.80	.41	13.61	14.7

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** B-RED	HRS-L ****							
+54GG P-2	100.0	40.92	40.92	9.22	9.22	.33	9.68	15.6
+9XX P-3	90.9	37.19	78.11	8.38	17.60	.32	9.62	15.1
+12XX 2 M	35.1	14.36	92.47	3.24	20.84	.31	9.43	15.2
-12XX FL	18.4	7.53	100.00	1.70	22.54	.32	9.72	15.1
**** B-RED	HRS-H ****							
+54GG P-2	98.6	44.02	44.02	9.29	9.29	.37	12.57	14.5
+9XX P-3	84.0	37.50	81.52	7.91	17.20	.37	13.13	14.2
+12XX 2 M	28.6	12.77	94.29	2.69	19.89	.38	13.52	14.1
-12XX FL	12.8	5.71	100.00	1.21	21.10	.39	14.08	14.5
**** B-RED	GAINES ****							
+54GG P-2	89.6	37.22	37.22	10.24	10.24	.31	7.89	13.9
+9XX P-3	83.6	34.73	71.96	9.55	19.79	.34	8.70	14.0
+12XX 2M	21.1	8.77	80.72	2.41	22.20	.33	9.00	14.0
-12XX FL	46.4	19.28	100.00	5.30	27.50	.33	8.28	13.8
**** B-RED	SRW ****							
+54GG P-2	95.0	30.84	30.84	9.98	9.98	.31	10.89	14.7
+9XX P-3	95.0	30.84	61.69	9.98	19.95	.32	11.38	14.6
+12XX 2M	47.0	15.26	76.95	4.94	24.89	.30	12.08	14.6
-12XX FL	71.0	23.05	100.00	7.46	32.34	.27	10.42	15.0
**** B-RED	HRW ****							
+54GG P-2	96.0	41.56	41.56	8.78	8.78	.38	10.59	14.7
+9XX P-3	88.0	38.10	79.65	8.05	16.83	.38	10.90	14.8
+12XX 2M	37.0	16.02	95.67	3.39	20.22	.38	10.93	14.2
-12XX FL	10.0	4.33	100.00	.91	21.13	.40	10.91	14.1

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** P-2	HRS-L ****							
ASP 5 BK	1:1	1:14	1:14	.10	.10	1:61	9:98	14:7
+34GG IT	1:9	1:97	3:12	.18	.28	1:52	9:75	15:3
+36GG C.S.	4:4	4:57	7:68	.41	.68	.68	9:92	15:0
-36GG F.S.	64:1	66:56	74:25	5:91	6:59	.31	9:70	15:8
-46GG 2M	24:8	25:75	100:00	2:29	8:88	.26	9:59	14:8
*** P-2 9	HRS-H ****							
ASP 5 BK	.5	.52	.52	.05	.05	1:27	15:21	11:8
+34GG IT	1:4	1:44	1:96	.13	.18	.53	12:36	13:7
+36GG C.S.	2:9	2:99	4:95	.27	.45	1:09	13:26	13:1
-36GG F.S.	50:9	52:53	57:48	.79	5:25	.34	12:43	14:2
-46GG 2M	41:2	42:52	100:00	3:88	9:13	.31	12:69	14:6
*** P-2	GAINES ****							
ASP 5 BK	.4	.47	.47	.05	.05	.99	8:32	13:2
+34GG IT	2:7	3:16	3:63	.31	.35	.68	8:44	13:4
+36GG C.S.	2:7	3:16	6:79	.31	.66	.42	7:67	13:7
-36GG F.S.	53:7	62:88	69:67	6:13	6:80	.30	7:98	13:8
-46GG IM	25:9	30:33	100:00	2:96	9:76	.29	8:31	13:1
*** P-2	SRW ****							
ASP 5 BK	3:9	4:11	4:11	.41	.41	.50	8:95	14:5
+34GG IT	2:1	2:21	6:32	.22	.63	.35	10:22	14:2
+36GG C.S.	4:0	4:21	10:53	.42	1:05	.45	9:54	14:4
-36GG F.S.	63:0	66:32	76:84	6:62	7:67	.29	10:86	14:5
-46GG IM	22:0	23:16	100:00	2:31	9:98	.27	11:16	14:5
*** P-2	HRW ****							
ASP 5 BK	.0	.00	.00	.00	.00	.00	.00	.0
+34GG IT	.0	.00	.00	.00	.00	1:37	11:38	12:9
+36GG C.S.	.0	.00	.00	.00	.00	.32	10:62	10:2
-36GG F.S.	38:0	40:43	40:43	3:48	3:48	.42	10:42	14:2
-46GG IM	56:0	59:57	100:00	5:12	8:60	.34	10:39	13:9

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** P-3	HRS-L ****							
+42GG 1T	2.1	2.30	2.30	.19	.19	.57	9.52	15.1
+50GG 2Q	14.4	15.75	18.05	1.33	1.52	.50	9.45	15.4
-50GG 1M	53.3	58.32	76.37	4.91	6.44	.30	9.57	15.5
-64GG 1M	21.6	23.63	100.00	1.99	8.43	.56	9.85	15.3
**** P-3 9	HRS-H ****							
+42GG 1T	.6	.75	.75	.06	.06	.83	14.10	13.4
+50GG 2Q	5.9	7.39	8.15	.56	.61	.81	13.12	13.5
-50GG 1M	42.1	52.76	60.90	3.97	4.58	.33	14.23	14.2
-64GG 1M	31.2	39.10	100.00	2.94	7.52	.27	12.80	14.0
**** P-3	GAINES ****							
+42GG 1T	1.3	1.60	1.60	.15	.15	.50	8.76	13.6
+50GG 2Q	11.7	14.37	15.97	1.34	1.49	.43	8.40	14.0
-50GG 1M	45.1	55.41	71.38	5.15	6.64	.31	8.49	13.9
-64GG 2M	23.3	28.62	100.00	2.66	9.30	.28	8.78	13.8
**** P-3	SRW ****							
+42GG 1T	.0	.00	.00	.00	.00	.00	.00	.0
+50GG 2Q	.6	.58	.58	.06	.06	.44	10.41	14.1
-50GG 1M	31.5	30.55	31.13	3.31	3.37	.36	10.25	14.4
-64GG 2M	71.0	68.87	100.00	7.46	10.83	.27	11.57	14.5
**** P-3	HRW ****							
+42GG 1T	.0	.00	.00	.00	.00	1.36	11.10	11.7
+50GG 2Q	.0	.00	.00	.00	.00	.00	.00	.0
-50GG 1M	72.0	85.71	85.71	6.59	6.59	.37	11.01	14.1
-64GG 2M	12.0	14.29	100.00	1.10	7.69	.31	10.61	14.1
**** P-3	HRW-4 ****							
+42GG 1T	3.1	3.37	3.37	.28	.28	.76	11.63	13.5
+50GG 2Q	8.1	8.78	12.15	.74	1.02	.61	11.31	13.3
-50GG 1M	26.5	28.78	40.93	2.43	3.45	.35	10.65	14.4
-64GG 2M	54.5	59.07	100.00	2.98	8.43	.31	10.38	13.8

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** P-4	HRS-L ***							
+26GG 1T	15.8	15.94	15.94	1.46	1.46	3.39	14.57	13.8
+36GG 2Q	9.9	9.99	25.93	.91	2.37	1.91	12.69	14.6
-36GG 2Q	15.4	15.54	41.47	1.42	3.79	.78	11.30	15.5
-44GG F.S.	58.0	58.53	100.00	5.35	9.14	.39	10.16	10.3
*** P-4 9	HRS-H ***							
+26GG 1T	19.5	18.93	18.93	1.84	1.84	3.34	16.69	12.4
+36GG 2Q	9.6	9.32	28.25	.90	2.74	1.89	14.25	13.7
-36GG 2Q	13.9	13.50	41.75	1.31	4.05	.83	12.90	14.0
-44GG F.S.	60.0	58.25	100.00	5.65	9.70	.39	13.33	14.2
*** P-4	GAINES ***							
+26GG 1T	13.4	24.23	24.23	1.53	1.53	2.85	14.66	12.6
+36GG 2Q	7.0	12.66	36.89	.80	2.33	2.55	15.98	12.3
-36GG 2Q	13.6	24.59	61.48	1.55	3.88	1.39	12.40	13.3
-44GG F.S.	21.3	38.52	100.00	2.43	6.32	.50	9.72	14.2
*** P-4	SRW ***							
+26GG 1T	6.5	13.46	13.46	.68	.68	3.26	15.82	13.0
+36GG 2Q	7.8	16.15	29.61	.82	1.50	3.17	17.81	13.1
-36GG 2Q	34.0	70.39	100.00	3.57	5.07	2.49	16.36	13.8
-44GG F.S.	.0	.00	100.00	.00	5.07	1.21	14.00	14.6
*** P-4	HRW ***							
+26GG 1T	13.0	13.27	13.27	1.19	1.19	3.78	17.20	13.5
+36GG 2Q	2.0	2.04	15.31	.18	1.37	2.50	14.00	13.1
-36GG 2Q	11.0	11.22	26.53	1.01	2.38	1.50	12.87	13.8
-44GG F.S.	72.0	73.47	100.00	6.59	8.97	.56	12.21	14.8

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** C.S.	HRS-L ****							
+22GG IT	9.6	4.30	4.30	89	89	3.74	21.02	14.9
+70GG P-5	186.0	83.33	87.63	17.15	18.04	.49	9.81	15.8
+11XX IM	10.4	4.66	92.29	1.53	18.99	.26	9.70	14.9
-10XX T.FL	16.6	7.44	99.73	.06	20.53	.29	10.02	15.0
-11XX B.FL	.6	.27	100.00		20.58	.26	9.56	14.5
*** C.S.	HRS-H ****							
+22GG IT	9.6	4.04	4.04	90	90	3.32	22.26	11.9
+70GG P-5	203.3	85.60	89.64	19.15	20.05	.47	11.24	14.3
+11XX IM	8.3	3.49	93.14	1.78	20.83	.27	11.20	14.0
-10XX T.FL	15.4	6.48	99.62	1.45	22.29	.31	12.07	14.5
-11XX B.FL	.9	.38	100.00	.08	22.37	.28	11.29	14.7
*** C.S.	GAINES ****							
+22GG IT	8.2	5.06	5.06	94	94	3.03	20.40	11.9
+70GG P-5	135.0	83.33	88.40	15.42	16.36	.44	7.67	13.7
+11XX IM	5.9	3.64	92.04	.67	17.03	.28	7.36	13.5
-10XX T.FL	12.1	7.47	99.51	1.38	18.41	.27	6.26	13.5
-11XX B.FL	.8	.49	100.00	.09	18.51	.26	7.29	13.9
*** C.S.	SRW ****							
+22GG IT	9.3	7.15	7.15	98	98	2.76	17.24	12.7
+70GG P-5	110.0	84.55	91.70	11.55	12.53	.49	10.19	13.9
+11XX IM	1.5	1.15	92.85	.16	12.69	.25	10.40	14.0
-10XX T.FL	8.7	6.69	99.54	.91	13.60	.24	7.76	14.7
-11XX B.FL	.6	.46	100.00	.06	13.66	.25	10.38	14.7
*** C.S.	HRW ****							
+22GG IT	10.0	4.05	4.05	91	91	3.17	18.92	13.2
+70GG P-5	215.0	87.04	91.09	19.67	20.59	.46	9.92	14.2
+11XX IM	7.0	2.83	93.93	.64	21.23	.32	.00	14.0
-10XX T.FL	14.0	5.67	99.60	1.28	22.51	.36	10.23	13.4
-11XX B.FL	1.0	.40	100.00	.09	22.60	.33	10.39	13.9

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** P-5	HRS-L ****							
+24GG IT	1.7	.88	.88	.16	.16	2.84	13.80	9.0
+28GG 2Q	2.8	1.46	2.34	.26	.41	2.31	12.83	14.2
-28GG F.S.	22.7	11.80	14.14	2.09	2.51	1.11	10.51	14.9
-44GG IM	165.1	85.86	100.00	15.22	17.73	.39	9.68	15.6
**** P-5	HRS-H ****							
+24GG IT	2.7	6.47	6.47	.25	.25	2.96	17.53	12.7
+28GG 2Q	3.8	9.11	15.59	.36	.61	2.09	14.65	13.7
-28GG F.S.	35.2	84.41	100.00	3.32	3.93	.99	11.68	13.1
-44GG IM	.0	.00	100.00	.00	3.93	.29	11.04	14.3
**** P-5	GAINES ****							
+24GG IT	1.1	.73	.73	.13	.13	2.97	18.78	13.0
+28GG 2Q	1.7	1.13	1.87	.19	.32	2.27	14.38	12.7
-28GG F.S.	22.0	14.69	16.56	2.51	2.83	.99	9.33	13.4
-44GG IM	125.0	83.44	100.00	14.28	17.11	.31	7.28	13.8
**** P-5	SRW ****							
+24GG IT	.9	.81	.81	.09	.09	2.38	14.09	13.3
+28GG 2Q	3.3	2.99	3.80	.35	.44	1.59	11.63	13.5
-28GG F.S.	25.3	22.90	26.70	2.66	3.10	1.01	10.46	14.5
-44GG IM	81.0	73.30	100.00	8.51	11.60	.36	10.18	14.7
**** P-5	HRW ****							
+24GG IT	6.0	2.99	2.99	.55	.55	4.49	14.97	13.8
+28GG 2Q	16.0	7.96	10.95	1.46	2.01	1.39	11.90	13.3
-28GG F.S.	63.0	31.34	42.29	5.76	7.77	.47	11.81	14.8
-44GG IM	116.0	57.71	100.00	10.61	18.39	.31	9.87	14.6

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** F.S.	HRS-L ***							
+40GG IT	7.0	3.07	3.07	.65	.65	2.09	12.44	13.6
+70GG P-6	126.4	55.49	58.56	11.66	12.30	.43	9.72	14.2
+11XX IM	58.1	25.50	84.06	5.36	17.66	.26	9.86	15.4
-10XX T.FL	33.5	14.71	98.77	3.09	20.75	.29	10.25	14.4
-11XX B.FL	2.8	1.23	100.00	.26	21.01	.28	9.88	14.7
*** F.S.	HRS-H ***							
+40GG IT	8.1	3.62	3.62	.76	.76	1.78	14.60	12.8
+70GG P-6	117.6	52.57	56.19	11.08	11.84	.42	12.23	14.2
+11XX IM	59.5	26.60	82.79	5.60	17.44	.38	12.49	13.9
-10XX T.FL	35.3	15.78	98.57	3.32	20.77	.31	12.13	14.2
-11XX B.FL	3.2	1.43	100.00	.30	21.07	.29	11.09	14.7
*** F.S.	GAINES ***							
+40GG IT	6.8	4.14	4.14	.78	.78	2.06	13.45	12.4
+70GG P-6	89.0	54.14	58.27	10.17	10.94	.41	17.95	13.5
+11XX IM	39.5	24.03	82.30	4.51	15.46	.27	8.00	12.9
-10XX T.FL	26.5	16.12	98.42	3.03	18.48	.28	6.78	13.8
-11XX B.FL	2.6	1.58	100.00	.30	18.78	.28	7.39	13.9
*** F.S.	SRW ***							
+40GG IT	9.0	5.23	5.23	.95	.95	1.39	11.83	13.5
+70GG P-6	69.0	40.12	45.35	7.25	8.19	.66	11.57	13.8
+11XX IM	53.0	30.81	76.16	5.57	13.76	.27	11.68	14.6
-10XX T.FL	34.0	19.77	95.93	3.57	17.33	.26	8.79	14.9
-11XX B.FL	7.0	4.07	100.00	.74	18.06	.25	10.51	14.9
*** F.S.	HRW ***							
+40GG IT	13.0	5.35	5.35	1.19	1.19	1.68	11.69	13.2
+70GG P-6	129.0	53.09	58.44	11.80	12.99	.42	10.32	14.2
+11XX IM	66.0	27.16	85.60	6.04	19.03	.29	10.72	14.2
-10XX T.FL	32.0	13.17	98.77	2.93	21.96	.33	10.79	13.9
-11XX B.FL	3.0	1.23	100.00	.27	22.23	.33	10.61	13.3

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** I M	HRS-L ****							
+40GG 1 T	.8	.27	.27	.07	.07	2.19	12.86	13.7
+70GG P-6	31.6	10.71	10.98	2.91	2.99	.68	10.02	15.0
+11XX 2 M	125.4	42.51	53.49	11.56	14.55	.27	9.35	12.6
-10XX T.FL	103.7	35.15	88.64	9.56	24.11	.24	9.50	14.9
-11XX B.FL	33.5	11.36	100.00	3.09	27.20	.25	9.50	14.9
**** I M	HRS-H ****							
+40GG 1 T	.4	.13	.13	.04	.04	1.88	14.81	12.9
+70GG P-6	34.2	11.15	11.29	3.22	3.26	.56	11.91	14.1
+11XX 2 M	151.4	49.38	60.67	17.26	17.52	.28	11.99	13.9
-10XX T.FL	75.1	24.49	85.16	7.07	24.59	.27	11.39	14.7
-11XX B.FL	45.5	14.84	100.00	4.29	28.88	.28	15.89	14.5
**** IM	GAINES ****							
+40GG 1T	1.6	.64	.64	.18	.18	1.96	12.57	12.4
+70GG P-6	20.6	8.18	8.82	2.35	2.54	.54	8.13	13.3
+11XX 2M	108.4	43.05	51.87	12.38	14.92	.28	8.02	13.1
-10XX T.FL	57.7	22.92	74.78	6.59	21.51	.25	6.80	14.0
-11XX B.FL	63.5	25.22	100.00	7.25	28.76	.29	7.48	13.8
**** IM	SRW ****							
+40GG 1T	2.0	1.24	1.24	.21	.21	2.64	14.68	12.1
+70GG P-6	21.0	13.04	14.29	2.21	2.42	.67	11.29	13.9
+11XX 2M	71.0	44.10	58.39	7.46	9.87	.30	11.86	14.4
-10XX T.FL	30.0	18.63	77.02	3.15	13.02	.23	8.67	14.7
-11XX B.FL	37.0	22.98	100.00	3.89	16.91	.23	9.78	14.7
**** IM	HRW ****							
+40GG 1T	3	.10	.10	.03	.03	1.58	12.37	13.1
+70GG P-6	25.0	8.16	8.26	2.29	2.31	.58	10.33	13.4
+11XX 2M	136.0	44.40	52.66	12.49	14.76	.30	10.40	14.0
-10XX T.FL	101.0	32.97	85.63	9.24	24.00	.29	10.46	13.7
-11XX B.FL	44.0	14.37	100.00	4.03	28.02	.28	10.71	14.1

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** P-6	HRS-L ****							
+26GG 1T	16.4	5.71	5.85	1.49	1.53	1.00	10.99	14.70
+40GG 2Q	133.0	46.90	52.75	12.26	13.79	1.31	9.83	15.17
-40GG 2M	134.0	47.25	100.00	12.36	26.15	1.38	9.80	14.19
**** P-6	HRS-H ****							
+26GG 1T	20.4	7.37	7.51	1.95	1.99	1.67	13.97	12.66
+40GG 2Q	133.2	47.42	54.93	12.55	14.53	1.40	12.50	14.00
-40GG 2M	126.6	45.07	100.00	11.92	26.46	1.35	12.20	14.00
-52GG 2M						1.37	12.07	13.88
**** P-6	GAINES ****							
+26GG 1T	3	8.28	8.62	3.03	3.03	1.72	8.44	13.44
+40GG 2Q	8.9	8.34	17.56	1.02	4.05	1.09	9.21	13.22
-40GG 2M	97.5	91.38	100.00	11.14	15.19	1.00	7.00	14.00
-52GG 2M						1.38	7.90	14.00
**** P-6	SRW ****							
+26GG 1T	1	18	18	1.01	1.01	1.82	11.15	14.44
+40GG 2Q	9.7	17.38	35.56	1.02	2.03	1.00	10.00	14.00
-40GG 2M	46.0	82.44	100.00	4.83	5.86	1.00	10.00	14.00
-52GG 2M	.0	.00	100.00	.00	5.86	1.00	10.00	14.00
**** P-6	HRW ****							
+26GG 1T	3.0	1.99	1.99	27	27	1.39	11.25	13.66
+40GG 2Q	5.0	3.31	5.30	46	73	1.78	10.85	13.66
-40GG 2M	20.0	13.25	18.54	1.83	2.56	1.76	10.00	13.66
-52GG 2M	123.0	81.46	100.00	11.25	13.82	1.34	10.54	14.33

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** 2 M	HRS-L ***							
+40GG 1T	1.6	.51	.51	.15	.15	2.48	13.70	13.4
+70GG P-6	35.7	11.28	11.78	3.29	3.44	.70	10.26	14.5
+11XX 3M	137.4	43.40	55.18	12.67	16.11	.28	9.70	14.9
-10XX T.FL	119.3	37.68	92.86	11.00	27.11	.25	9.77	14.6
-11XX B.FL	22.6	7.14	100.00	2.08	29.19	.25	9.47	14.6
*** 2 M	HRS-H ***							
+40GG 1T	1.5	.44	.44	.14	.14	1.38	13.96	12.5
+70GG P-6	33.6	9.76	10.20	3.16	3.31	.60	12.50	13.3
+11XX 3M	141.9	41.24	51.44	13.37	16.67	.30	12.30	13.3
-10XX T.FL	126.7	36.82	88.26	11.93	28.61	.29	14.83	14.2
-11XX B.FL	40.4	11.74	100.00	3.81	32.41	.25	12.06	14.4
*** 2M	GAINES ***							
+40GG 1T	1.0	.41	.41	.11	.11	2.15	14.07	12.0
+70GG P-7	30.9	12.66	13.07	3.53	3.64	.61	8.64	13.4
+11XX 3M	102.2	41.87	54.94	11.67	15.32	.30	7.34	13.4
-10XX T.FL	78.0	31.95	86.89	18.91	24.23	.28	7.49	13.9
-11XX B.FL	32.0	13.11	100.00	3.66	27.88	.28	7.97	13.7
*** 2M	SRW ***							
+40GG 1T	1.8	.63	.63	.19	.19	3.05	17.12	12.6
+70GG P-7	66.5	23.23	23.86	6.98	7.17	.63	12.03	14.2
+11XX 3M	127.0	44.36	68.22	13.34	20.51	.29	12.21	14.8
-10XX T.FL	58.0	20.26	88.47	6.09	26.60	.24	10.47	14.6
-11XX B.FL	33.0	11.53	100.00	3.47	30.06	.23	11.49	14.7
*** 2M	HRW ***							
+40GG 1T	.3	.10	.10	.03	.03	2.45	14.91	12.3
+70GG P-7	20.0	6.51	6.61	1.83	1.86	.65	11.00	13.2
+11XX 3M	134.0	43.61	50.21	12.26	14.12	.33	10.59	13.1
-10XX T.FL	126.0	41.00	91.21	11.53	25.65	.29	10.43	13.4
-11XX B.FL	27.0	8.79	100.00	2.47	28.12	.30	10.58	13.8

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** 2 Q	HRS-L ***							
+24GG 1T	9.2	16.31	16.31	.85	.85	3.38	15.19	13.4
+70GG P-7	26.8	47.52	63.83	2.47	3.32	1.01	10.57	14.6
+12XX 3M	12.0	21.28	85.11	1.11	4.43	.37	9.73	14.3
-12XX FL	8.4	14.89	100.00	.77	5.20	.47	10.11	14.1
*** 2 Q	HRS-H ***							
+24GG 1T	10.6	18.93	18.93	1.00	1.00	2.76	15.90	12.9
+70GG P-7	30.3	54.11	73.04	2.85	3.85	.91	12.64	12.9
+12XX 3M	9.3	16.61	89.64	.88	4.73	.44	12.84	13.6
-12XX FL	5.8	10.36	100.00	.55	5.27	.45	11.76	13.7
*** 2Q	GAINES ***							
+24GG 1T	10.6	27.82	27.82	1.21	1.21	2.73	16.17	11.7
+70GG P-7	19.8	51.97	79.79	2.26	3.47	1.09	10.38	13.0
+12XX 3M	4.0	10.50	90.29	.46	3.93	.44	8.54	13.4
-12XX FL	3.7	9.71	100.00	.42	4.35	.39	7.38	13.8
*** 2Q	SRW ***							
+24GG 1T	43.7	43.70	43.70	4.59	4.59	3.24	18.04	12.3
+70GG P-7	41.1	41.10	84.80	4.32	8.90	1.49	12.24	13.6
+12XX 3M	5.2	5.20	90.00	.55	9.45	.60	11.17	13.8
-12XX FL	10.0	10.00	100.00	1.05	10.50	.32	7.66	14.7
*** 2Q	HRW ***							
+24GG 1T	9.0	14.75	14.75	.82	.82	2.79	14.77	13.8
+70GG P-7	42.0	68.85	83.61	3.84	4.67	.79	10.53	13.4
+12XX 3M	6.0	9.84	93.44	.55	5.22	.43	10.43	13.4
-12XX FL	4.0	6.56	100.00	.37	5.58	.47	10.06	11.1

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** 4 BK HRS-L ****								
+20TT 5 BK	214.5	73.58	73.58	19.78	19.78	4.99	13.01	12.1
+36GG 5 BK	19.0	6.52	80.10	1.75	21.53	4.04	15.85	10.5
+8XX 9-7	29.5	10.12	90.22	2.72	24.25	1.21	12.53	14.9
+12XX 4 M	12.5	4.29	94.51	1.15	25.40	.41	12.53	14.9
-12XX FL	16.0	5.49	100.00	1.48	26.88	.43	13.51	14.7
**** 4 BK HRS-H ****								
+20TT 5 BK	198.9	70.61	70.61	18.73	18.73	5.17	15.99	11.8
+36GG 5 BK	22.4	7.95	78.56	2.11	20.84	5.24	16.09	11.3
+8XX 9-7	32.4	11.50	90.06	3.05	23.90	1.29	15.81	13.5
+12XX 4 M	12.0	4.26	94.32	1.13	25.03	.38	17.58	13.9
-12XX FL	16.0	5.68	100.00	1.51	26.53	.49	17.48	14.4
**** 4 BK GAINES ****								
+20TT 5 BK	154.0	74.11	74.11	17.59	17.59	4.04	13.18	10.6
+36GG 5 BK	14.6	7.03	81.14	1.67	19.26	3.31	13.62	11.6
+8XX P-7	14.9	7.17	88.31	1.70	20.96	1.86	13.22	12.2
+12XX 4M	9.6	4.62	92.93	1.10	22.06	.46	12.09	13.2
-12XX FL	14.7	7.07	100.00	1.68	23.74	.37	9.09	13.9
**** 4 BK SRW ****								
+20TT 5 BK	173.0	74.25	74.25	18.17	18.17	5.85	14.48	13.3
+36GG 5 BK	18.0	7.73	81.97	1.89	20.06	4.53	16.55	12.7
+8XX P-7	17.0	7.30	89.27	1.79	21.84	2.69	17.02	13.6
+12XX 4M	10.0	4.29	93.56	1.05	22.89	.52	18.42	14.1
-12XX FL	15.0	6.44	100.00	1.58	24.47	.38	12.46	14.4
**** 4 BK HRW ****								
+20TT 5 BK	208.0	74.55	74.55	19.03	19.03	5.06	15.58	15.0
+36GG 5 BK	20.0	7.17	81.72	1.83	20.86	4.27	18.81	15.4
+8XX P-7	25.0	8.96	90.68	2.29	23.15	1.93	15.31	15.2
+12XX 4M	12.0	4.30	94.98	1.10	24.25	.54	14.77	14.4
-12XX FL	14.0	5.02	100.00	1.28	25.53	.52	16.20	15.6

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** P-7	HRS-L	***						
+28LW 5 BK	1.8	2.47	2.47	.17	.17	3.25	13.11	10.1
+36LW 1T	5.6	7.67	10.14	.52	.68	1.81	11.94	14.3
-36LW 1T	23.9	32.74	42.88	2.20	2.89	.90	11.86	14.4
-50LW 3M	41.7	57.12	100.00	3.85	6.73	.52	10.40	14.8
*** P-7	HRS-H	***						
+28LW 5 BK	3.2	3.42	3.42	.30	.30	3.09	15.35	10.9
+36LW 1T	21.2	22.65	26.07	2.00	2.30	1.78	14.04	13.0
-36LW 1T	20.0	21.37	47.44	1.88	4.18	.98	13.59	13.3
-50LW 3M	49.2	52.56	100.00	4.63	8.82	.54	13.38	13.2
*** P-7	GAINES	***						
+28GG 5 BK	4.3	6.22	6.22	.49	.49	2.71	12.38	11.1
+36GG 1T	35.7	51.66	57.89	4.08	4.57	1.73	11.83	10.6
-36GG 1T	19.0	27.50	85.38	2.17	6.74	.84	10.03	13.4
-50GG 3M	10.1	14.62	100.00	1.15	7.89	.66	10.00	13.1
*** P-7	SRW	***						
+28GG 5 BK	12.0	13.95	13.95	1.26	1.26	2.07	13.40	12.7
+36GG 1T	33.0	38.37	52.33	3.47	4.73	1.40	13.37	13.8
-36GG 1T	29.0	33.72	86.05	3.05	7.77	.87	12.96	13.1
-50GG 3M	12.0	13.95	100.00	1.26	9.03	.63	12.86	13.7
*** P-7	HRW	***						
+28GG 5 BK	3.0	2.56	2.56	.27	.27	3.23	14.85	12.0
+36GG 1T	36.0	30.77	33.33	3.29	3.57	1.39	12.40	13.3
-36GG 1T	32.0	27.35	60.68	2.93	6.50	.49	10.97	13.8
-50GG 3M	46.0	39.32	100.00	4.21	10.70	.73	10.92	13.4

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** 3 M	HRS-L ****							
+60GG 1T	12.8	6.28	6.28	1.18	1.18	1.40	11.84	14.3
+11XX 4M	80.9	39.70	45.98	7.46	8.64	.39	9.91	14.1
-11XX FL	110.1	54.02	100.00	10.15	18.79	.26	9.70	14.0
**** 3 M	HRS-H ****							
+60GG 1T	14.0	7.15	7.15	1.32	1.32	1.38	14.00	12.8
+11XX 4M	52.2	26.65	33.79	4.92	6.24	.41	12.88	13.2
-11XX FL	129.7	66.21	100.00	12.22	18.45	.24	12.14	14.3
**** 3M	GAINES ****							
+60GG 1T	9.7	7.34	7.34	1.11	1.11	1.46	11.19	11.6
+11XX 4M	37.9	28.69	36.03	4.33	5.44	.43	8.78	13.8
-11XX FL	84.5	63.97	100.00	9.65	15.09	.30	8.15	13.5
**** 3M	SRW ****							
+60GG 1T	5.0	3.14	3.14	.53	.53	2.36	15.90	12.4
+11XX 4M	81.0	50.94	54.09	8.51	9.03	.50	13.05	13.7
-11XX FL	73.0	45.91	100.00	7.67	16.70	.23	11.29	14.7
**** 3M	HRW ****							
+64GG 1T	4.0	2.35	2.35	.37	.37	1.96	13.73	12.3
+12XX 4M	56.0	32.94	35.29	5.12	5.49	.47	10.74	13.5
-12XX FL	110.0	64.71	100.00	10.06	15.55	.32	10.59	13.1

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** I T	HRS-L ***							
+32GG G-SC	37.0	42.63	42.63	3.41	3.41	3.93	16.98	12.4
+60GG 5M	21.3	24.54	67.17	1.96	5.38	2.83	12.95	15.0
+13XX 4M	22.2	25.58	92.74	2.05	7.42	.60	10.35	14.4
-13XX FL	6.3	7.26	100.00	.58	8.00	.62	10.48	13.0
*** I T	HRS-H ***							
+32GG G-SC	41.1	43.49	43.49	3.87	3.87	3.55	18.14	10.4
+60GG 5M	25.0	26.46	69.95	2.35	6.23	2.16	14.15	12.5
+13XX 4M	21.4	22.65	92.59	2.02	8.24	.65	13.08	13.2
-13XX FL	7.0	7.41	100.00	.66	8.90	.55	12.06	13.7
*** I T	GAINES ***							
+32GG G-SC	38.3	35.69	35.69	4.38	4.38	3.17	17.42	13.1
+60GG 5M	37.6	35.04	70.74	4.30	8.67	2.03	12.67	11.1
+13XX 4M	26.2	24.42	95.15	2.99	11.66	.63	9.00	13.0
-13XX FL	5.2	4.85	100.00	.59	12.26	.45	7.65	13.4
*** I T	SRW ***							
+32GG G-SC	38.0	33.93	33.93	3.99	3.99	3.60	18.00	11.6
+60GG 5M	36.0	32.14	66.07	3.78	7.77	2.54	15.26	12.1
+13XX 4M	29.0	25.89	91.96	3.05	10.82	.68	12.71	13.4
-13XX FL	9.0	8.04	100.00	.95	11.76	.32	7.96	14.7
*** I T	HRW ***							
+32GG G-SC	37.0	33.33	33.33	3.39	3.39	3.86	18.01	13.1
+60GG 5M	32.0	28.83	62.16	2.93	6.31	2.16	13.47	12.5
+13XX 4M	36.0	32.43	94.59	3.29	9.61	.78	11.84	15.0
-13XX FL	6.0	5.41	100.00	.55	10.16	.66	11.39	12.4

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** 4 M	HRS-L ****							
+44GG 5 BK	3	26	26	03	03	72	10.44	14.3
+12XX 5M	40.6	35.71	35.97	3.74	3.77	.61	10.28	13.8
-12XX FL	72.8	64.03	100.00	6.71	10.48	.29	10.15	13.6
**** 4 M	HRS-H ****							
+44GG 5 BK	9	79	79	08	08	.68	13.46	13.1
+12XX 5M	37.4	32.75	33.54	3.52	3.61	.64	13.47	12.5
-12XX FL	75.9	66.46	100.00	7.15	10.76	.34	12.84	13.6
**** 4M	GAINES ****							
+44GG 5 BK	3	53	53	03	03	.68	9.25	12.6
+12XX 5M	12.4	22.02	22.56	1.42	1.45	.62	9.07	12.8
-12XX FL	43.6	77.44	100.00	4.98	6.43	.38	9.35	13.5
**** 4M	SRW ****							
+44GG 5 BK	3	21	21	03	03	1.37	14.82	12.4
+12XX 5M	97.0	68.65	68.86	10.19	10.22	.48	13.09	13.3
-12XX FL	44.0	31.14	100.00	4.62	14.84	.31	12.99	15.9
**** 4M	HRW ****							
+44GG 5 BK	0	00	00	00	00	.00	.00	.0
+12XX 5M	41.0	37.27	37.27	3.75	3.75	.74	11.23	12.7
-12XX FL	69.0	62.73	100.00	6.31	10.06	.38	11.57	12.3

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** SUC	HRS-L ***							
+18TT 5 BK	3	2.80	2.80	.03	.03	1.50	3.93	8.1
+54GG 5 BK	3.4	31.78	34.58	.31	.34	2.11	8.34	10.3
+13XX 5M	4.3	40.19	74.77	.40	.74	.85	10.27	12.9
-13XX FL	2.7	25.23	100.00	.25	.99	.49	10.43	16.7
*** SUC	HRS-H ***							
+18TT 5 BK	4	3.54	3.54	.04	.04	2.40	4.81	7.0
+54GG 5 BK	4.9	43.36	46.90	.46	.50	2.68	10.03	10.0
+13XX 5M	3.9	34.51	81.42	.37	.87	1.17	13.62	11.6
-13XX FL	2.1	18.58	100.00	.20	1.06	.49	12.09	12.5
*** SUC	GAINES ***							
+18TT 5 BK	3	2.03	2.03	.03	.03	2.68	4.87	13.4
+54GG 5 BK	3.5	23.65	25.68	.40	.43	2.40	9.42	10.5
+13XX 5M	8.6	58.11	83.78	.98	1.42	.71	10.21	12.4
-13XX FL	2.4	16.22	100.00	.27	1.69	.47	11.26	12.9
*** SUC	SRW ***							
+18TT 5 BK	3	1.37	1.37	.03	.03	2.21	7.11	10.5
+54GG 5 BK	6.3	28.77	30.14	.66	.69	1.77	11.20	12.5
+13XX 5M	10.9	49.77	79.91	1.14	1.84	.62	13.31	13.4
-13XX FL	4.4	20.09	100.00	.46	2.30	.47	12.61	12.7
*** SUC	HRW ***							
+18TT 5 BK	0	.00	.00	.00	.00	.00	.00	.0
+54GG 5 BK	3.0	23.08	23.08	.27	.27	.71	9.60	11.3
+13XX 5M	5.0	38.46	61.54	.46	.73	.98	11.45	12.1
-13XX FL	5.0	38.46	100.00	.46	1.19	.62	13.86	11.3

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** 5 BK	HRS-L ****							
+20TT B.D.	178.0	69.78	69.78	16.41	16.41	5.59	12.65	12.3
+50GG S.D.	40.5	15.88	85.65	3.73	20.15	3.90	14.84	11.9
+13XX 5M	18.6	7.29	92.94	1.72	21.86	1.30	12.95	14.3
-13XX FL	18.0	7.06	100.00	1.66	23.52	.67	15.40	14.0
**** 5 BK	HRS-H ****							
+20TT B.D.	168.7	69.31	69.31	15.89	15.89	6.01	15.32	11.3
+50GG S.D.	44.0	18.08	87.39	4.14	20.03	3.85	16.16	10.6
+13XX 5M	14.4	5.92	93.30	1.36	21.39	1.48	16.96	12.8
-13XX FL	16.3	6.70	100.00	1.54	22.93	.63	18.84	14.2
**** 5 BK	GAINES ****							
+20TT B.D.	124.5	69.94	69.94	14.22	14.22	4.44	13.14	11.0
+50GG S.D.	30.4	17.08	87.02	3.47	17.69	2.81	15.19	11.1
+13XX 5M	6.1	3.43	90.45	.70	18.39	1.37	12.23	12.1
-13XX FL	17.0	9.55	100.00	1.94	20.33	.52	10.94	13.5
**** 5 BK	SRW ****							
+20TT B.D.	148.6	70.90	70.90	15.60	15.60	6.45	14.09	13.3
+50GG S.D.	37.0	17.65	88.55	3.89	19.49	4.03	14.46	12.6
+13XX 5M	9.7	4.63	93.18	1.02	20.51	1.49	15.01	13.5
-13XX FL	14.3	6.82	100.00	1.50	22.01	.55	14.43	14.2
**** 5 BK	HRW ****							
+20TT B.D.	174.0	75.00	75.00	15.92	15.92	5.54	15.71	14.6
+50GG S.D.	36.0	15.52	90.52	3.29	19.21	4.02	17.60	14.5
+13XX 5M	7.0	3.02	93.53	.64	19.85	2.08	16.03	13.1
-13XX FL	15.0	6.47	100.00	1.37	21.23	.74	17.99	13.0

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** 5 M	HRS-L ****							
+54GG S.D.	9.9	15.18	15.18	.91	.91	3.54	14.74	12.5
+13XX 6M	16.8	25.77	40.95	1.55	2.46	1.58	11.88	13.1
-13XX FL	38.5	59.05	100.00	3.55	6.01	.45	10.29	13.1
**** 5 M	HRS-H ****							
+54GG S.D.	11.2	23.19	23.19	1.05	1.05	1.26	15.88	11.2
+13XX 6M	10.9	22.57	45.76	1.03	2.08	1.66	14.64	11.9
-13XX FL	26.2	54.24	100.00	2.47	4.55	.40	12.73	13.5
**** 5M	GAINES ****							
+54GG S.D.	10.2	20.73	20.73	1.17	1.17	3.27	12.68	10.5
+13XX 6M	22.1	44.92	65.65	2.52	3.69	1.27	10.95	12.0
-13XX FL	16.9	34.35	100.00	1.93	5.62	.49	8.74	13.4
**** 5M	SRW ****							
+54GG S.D.	20.0	20.04	20.04	2.10	2.10	3.01	16.68	11.3
+13XX 6M	46.4	46.49	66.53	4.87	6.97	.88	14.12	12.9
-13XX FL	33.4	33.47	100.00	3.51	10.48	.36	11.00	14.0
**** 5M	HRW ****							
+54GG S.D.	12.0	25.53	25.53	1.10	1.10	1.54	16.70	10.9
+13XX 6M	11.0	23.40	48.94	1.01	2.10	1.47	12.80	12.0
-13XX FL	24.0	51.06	100.00	2.20	4.30	.63	11.71	11.9

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
*** B+SD HRS-L ***								
+54GG FEED	19.3	35.09	35.09	1.78	1.78	3.44	15.94	12.6
+12XX 6M	12.2	22.18	57.27	1.12	2.90	3.07	15.34	13.1
-12XX FL	23.5	42.73	100.00	2.17	5.07	1.59	13.67	13.2
*** B+SD HRS-H ***								
+54GG FEED	26.8	40.18	40.18	2.52	2.52	3.32	16.99	11.9
+12XX 6M	10.8	16.19	56.37	1.02	3.54	2.84	16.83	12.1
-12XX FL	29.1	43.63	100.00	2.74	6.28	1.29	15.72	13.0
*** B+SD GAINES ***								
+54GG FEED	10.2	25.37	25.37	1.17	1.17	2.79	12.71	10.7
+12XX 6M	5.0	12.44	37.81	.57	1.74	2.35	13.68	12.0
-12XX FL	25.0	62.19	100.00	2.86	4.59	1.09	10.48	13.0
*** B+SD SRW ***								
+54GG FEED	27.7	37.18	37.18	2.91	2.91	3.59	16.58	11.3
+12XX 6M	18.4	24.70	61.88	1.93	4.84	.00	.00	.0
-12XX FL	28.4	38.12	100.00	2.98	7.82	.98	13.42	14.1
*** B+SD HRW ***								
+54GG FEED	17.0	35.42	35.42	1.56	1.56	3.81	18.84	11.9
+12XX 6M	10.0	20.83	56.25	.91	2.47	3.02	17.14	11.7
-12XX FL	21.0	43.75	100.00	1.92	4.39	1.57	15.87	12.2

STREAM NAME	POUNDS PER HOUR	PERCENT OF SYSTEM	CUMULATIVE PERCENT SYSTEM	PERCENT OF WHEAT	CUMULATIVE PERCENT WHEAT	ASH	PROTEIN	MOISTURE
**** 6 M	HRS-L	****						
+13XX R·DG	20.8	54.03	54.03	1.92	1.92	2.85	14.27	12.6
-13XX FL	17.7	45.97	100.00	1.63	3.55	.84	11.07	13.0
**** 6 M	HRS-H	****						
+13XX R·DG	16.0	35.71	35.71	1.51	1.51	2.53	15.97	11.7
-13XX FL	28.8	64.29	100.00	2.71	4.22	.53	13.36	13.1
**** 6M	GAINES	****						
+13XX R·DG	58.2	58.20	58.20	6.65	6.65	1.95	12.59	11.9
-13XX FL	41.8	41.80	100.00	4.77	11.42	.80	10.07	12.9
**** 6M	SRW	****						
+13XX R·DG	51.5	58.19	58.19	5.41	5.41	1.47	15.33	12.5
-13XX FL	37.0	41.81	100.00	3.89	9.29	.39	12.53	14.2
**** 6M	HRW	****						
+13XX R·DG	12.0	54.55	54.55	1.10	1.10	1.64	14.27	10.8
-13XX FL	10.0	45.45	100.00	.91	2.01	.75	11.04	10.4

APPENDIX B

CUMULATIVE ASH AND PROTEIN

*** HRS-L	YIELD=76.73	****	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS B	1719.	4.55	4.55			.229	1.64	1.64	.229	9.6	9.6
2 MIDS B	963.	2.55	18.09			.238	2.61	1.65	.237	9.5	9.5
3 MIDS T	4582.	11.12	30.24			.252	3.68	4.33	.247	9.4	9.4
4 MIDS B	39.	1.10	30.36			.269	3.05	7.38	.243	9.8	9.8
5 MIDS B	4363.	11.54	42.00			.277	3.20	7.41	.243	9.7	9.7
6 MIDS B	90.	3.51	45.24			.279	3.97	10.68	.253	10.0	10.0
7 MIDS T	1326.	1.73	47.75			.282	5.0	11.66	.255	10.0	10.0
8 MIDS T	655.	1.67	49.48			.291	5.4	12.17	.256	10.6	10.6
9 MIDS T	633.	5.21	54.69			.323	1.81	14.52	.259	10.5	10.5
10 MIDS T	1924.	4.11	58.80			.346	1.42	15.94	.272	10.6	10.6
11 MIDS T	1554.	2.74	61.28			.373	1.02	16.97	.277	10.0	10.0
12 MIDS T	1038.	1.15	61.43			.379	1.06	18.02	.277	11.9	11.9
13 MIDS T	57.	3.26	64.59			.447	2.40	19.67	.285	13.5	13.5
14 MIDS T	1233.	1.83	67.42			.448	3.2	19.49	.289	11.2	11.2
15 MIDS T	341.	1.32	70.03			.498	1.67	21.02	.290	11.5	11.5
16 MIDS T	691.	2.29	72.58			.598	1.37	22.43	.303	15.5	15.5
17 MIDS T	120.	2.66	74.28			.623	1.41	24.77	.316	11.6	11.6
18 MIDS T	866.	1.89	76.73			.798	1.83	29.30	.333	11.0	11.0
19 MIDS T	250.	1.70				1.075	4.54		.382		
20 MIDS T	643.	2.45				1.855					
21 MIDS T	925.										

STREAM WEIGHT (GRAMS/5 MINUTES)
 PERCENT OF TOTAL PRODUCTS
 SUM OF PERCENT OF TOTAL PRODUCTS
 PERCENT OF SAMPLE WEIGHT *
 (PERCENT OF TOTAL PRODUCTS) X (ASH)
 SUM OF QXA
 CUMULATIVE ASH (S OF QXA)/(S OF Q)
 CUMULATIVE PERCENT OF SAMPLE WEIGHT *
 CUMULATIVE PERCENT OF PROTEIN
 CUMULATIVE PERCENT OF MOISTURE BASIS

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**** HRS-H      YIELD=74.68  ****
STREAM      STR WT      PCENT      S OF Q      ASH      QXA      S OF QXA      CUM ASH      PROT      CUM PROT
1 MIDS B      1720.      4.45      4.45      .238      1.06      1.06      .238      11.37      11.72
2 SIZ B T      35.      0.09      4.54      .249      1.02      2.08      .239      11.50      11.60
3 MIDS T      4793.      7.36      11.90      .258      1.90      3.98      .251      11.81      11.81
4 MIDS B      4906.      12.41      24.31      .268      3.33      7.31      .260      12.04      12.04
5 MIDS T      1528.      12.70      37.02      .277      3.52      10.83      .266      12.40      12.40
6 SIZ B T      1583.      13.96      40.97      .282      1.10      11.93      .267      12.60      12.60
7 SIZ B T      1335.      1.32      42.80      .289      .09      12.02      .268      12.96      12.96
8 SIZ B T      2870.      3.46      46.25      .319      1.10      13.12      .272      12.99      12.99
9 MIDS B      1003.      7.43      53.69      .324      2.49      15.61      .279      12.15      12.15
10 BK          1941.      2.60      56.94      .390      1.16      16.77      .281      12.33      12.33
11 BK          221.      2.44      59.98      .447      1.10      17.87      .295      12.47      12.47
12 QUAL        992.      2.57      60.55      .456      1.21      19.08      .304      12.49      12.49
13 MIDS        683.      1.77      63.12      .472      .80      20.88      .309      12.56      12.56
14 BK          607.      1.57      64.89      .507      .11      21.99      .313      12.67      12.67
15 SUCTION     81.      .21      66.46      .540      .41      22.40      .314      12.67      12.67
16 TAILS       266.      .69      67.36      .591      .03      22.43      .317      12.67      12.67
17 PRE BK      19.      .05      67.41      .614      .04      22.47      .325      12.82      12.82
18 PRE BK      618.      1.60      69.01      .652      1.04      23.51      .341      12.87      12.87
19 MIDS        1089.      2.82      71.83      .742      2.09      25.60      .385      14.29      14.29
20 B AND SD    1102.      2.85      74.68      1.476      4.21      28.73      .385      15.29      15.29

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STREAM WEIGHT (GRAMS/5 MINUTES
PERCENT OF TOTAL PRODUCTS
SUM OF PERCENT OF TOTAL PRODUCTS
ASH (S OF QXA)/(S OF Q)
CUMULATIVE PERCENT OF SAMPLE WEIGHT *
PROTEIN, PERCENT OF SAMPLE WEIGHT *
CUMULATIVE PERCENT OF SAMPLE WEIGHT *
14 PERCENT MOISTURE BASIS

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**** GAINES YIELD=77.03 ****

STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS T	2137.	6.81	6.81	.258	1.76	1.76	.258	7.1	7.06
1 MIDS B	2526.	7.97	14.68	.259	2.94	3.80	.259	7.7	7.39
1 MIDS T	1104.	3.44	18.12	.268	2.92	4.72	.261	7.3	7.55
2 MIDS T	442.	1.38	19.49	.269	3.37	5.09	.261	6.4	7.47
2 MIDS B	2865.	8.92	28.41	.269	2.40	7.49	.264	7.9	7.60
2 MIDS T	95.	.30	28.50	.270	.08	7.52	.264	7.5	7.60
2 MIDS B	990.	3.08	31.38	.289	.89	8.49	.266	7.0	7.54
3 MIDS	3335.	10.39	42.27	.298	3.09	11.58	.274	8.5	7.78
3 MIDS B	1526.	4.75	47.02	.310	1.47	13.05	.279	9.7	7.60
1 BK	1765.	2.38	49.40	.311	1.10	14.15	.282	5.1	7.63
1,2,3 RED	1113.	3.47	52.87	.328	1.80	16.00	.286	8.8	7.73
4 MIDS	2583.	5.50	58.37	.357	2.87	19.57	.295	9.6	7.96
4 MIDS B	425.	1.32	67.73	.368	2.49	20.06	.297	9.0	7.98
2 QUAL	145.	1.45	68.19	.378	1.17	20.23	.297	7.3	8.00
SUCTION	179.	.25	68.43	.421	1.07	20.33	.298	6.8	8.00
1 TAILS	202.	.63	69.06	.426	1.76	20.68	.299	8.8	8.00
PRE BK	57.	.18	69.24	.459	.04	21.44	.303	7.7	8.02
5 MIDS	505.	1.57	70.81	.524	1.04	22.48	.309	11.0	8.11
5 MIDS B	636.	1.98	72.79	.906	.99	23.47	.318	11.8	8.16
6 MIDS	350.	1.09	73.88	.949	2.99	26.45	.343	9.8	8.23
B AND SD	1011.	3.15	77.03						

STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS T	2137.	6.81	6.81	.258	1.76	1.76	.258	7.1	7.06
1 MIDS B	2526.	7.97	14.68	.259	2.94	3.80	.259	7.7	7.39
1 MIDS T	1104.	3.44	18.12	.268	2.92	4.72	.261	7.3	7.55
2 MIDS T	442.	1.38	19.49	.269	3.37	5.09	.261	6.4	7.47
2 MIDS B	2865.	8.92	28.41	.269	2.40	7.49	.264	7.9	7.60
2 MIDS T	95.	.30	28.50	.270	.08	7.52	.264	7.5	7.60
2 MIDS B	990.	3.08	31.38	.289	.89	8.49	.266	7.0	7.54
3 MIDS	3335.	10.39	42.27	.298	3.09	11.58	.274	8.5	7.78
3 MIDS B	1526.	4.75	47.02	.310	1.47	13.05	.279	9.7	7.60
1 BK	1765.	2.38	49.40	.311	1.10	14.15	.282	5.1	7.63
1,2,3 RED	1113.	3.47	52.87	.328	1.80	16.00	.286	8.8	7.73
4 MIDS	2583.	5.50	58.37	.357	2.87	19.57	.295	9.6	7.96
4 MIDS B	425.	1.32	67.73	.368	2.49	20.06	.297	9.0	7.98
2 QUAL	145.	1.45	68.19	.378	1.17	20.23	.297	7.3	8.00
SUCTION	179.	.25	68.43	.421	1.07	20.33	.298	6.8	8.00
1 TAILS	202.	.63	69.06	.426	1.76	20.68	.299	8.8	8.00
PRE BK	57.	.18	69.24	.459	.04	21.44	.303	7.7	8.02
5 MIDS	505.	1.57	70.81	.524	1.04	22.48	.309	11.0	8.11
5 MIDS B	636.	1.98	72.79	.906	.99	23.47	.318	11.8	8.16
6 MIDS	350.	1.09	73.88	.949	2.99	26.45	.343	9.8	8.23
B AND SD	1011.	3.15	77.03						

14 PERCENT MOISTURE BASIS

**** SRW YIELD=72.33 ****

STREAM	STR WT	PCENT	S OF O	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS T	1229.	3.59	3.59	210	75	75	210	8.7	8.70
1 MIDS B	1510.	4.42	8.01	230	01	1.77	221	10.3	9.47
2 MIDS T	2213.	3.47	11.53	240	81	2.58	230	11.4	10.02
2 C SIZ T	318.	0.93	18.00	250	56	4.13	231	17.0	10.04
2 BK SIZ T	1852.	5.42	18.93	253	23	4.37	236	8.0	9.59
2 F SIZ B	1333.	3.90	24.35	261	02	5.74	239	9.2	9.54
3 MIDS B	2547.	7.45	28.32	270	02	6.77	246	10.4	9.93
1 BK SIZ B	750.	2.86	35.76	273	01	8.78	248	11.4	9.94
1,2,3 RED	2613.	7.19	36.62	281	60	9.01	253	16.7	9.75
3 BK MIDS	1306.	3.82	38.81	291	15	11.76	256	10.5	9.88
4 MIDS	1557.	4.55	46.46	307	11	12.87	260	10.0	9.90
6 MIDS	1659.	4.85	50.28	358	14	14.01	267	13.0	9.96
2 QUAL	133.	0.39	58.53	378	63	15.64	276	17.7	10.20
4 BK	533.	1.56	63.77	391	15	17.62	279	12.5	10.39
SUCTION	290.	0.97	65.33	408	33	18.56	280	12.4	10.47
1 TAILS	330.	0.09	66.17	476	40	18.96	283	8.7	10.44
PRE BK	600.	1.75	67.24	538	04	19.00	289	14.8	10.55
5 BK	1142.	3.34	72.33	1186	96	23.90	330	13.8	10.70

STREAM WEIGHT (GRAMS/5 MINUTES
 PERCENT OF TOTAL PRODUCTS
 SUM OF PERCENT OF TOTAL PRODUCTS
 PERCENT OF SAMPLE WEIGHT *
 (PERCENT OF TOTAL PRODUCTS) X (ASH)
 SUM OF QXA
 CUMULATIVE ASH (S OF QXA)/(S OF O)
 PERCENT OF SAMPLE WEIGHT *
 CUMULATIVE PERCENT OF PROTEIN
 CUMULATIVE PERCENT MOISTURE BASIS

**** HRW-L YIELD=73.00 ****

STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS B	1287.	3.19	3.19	.273	.87	.87	.273	9.4	9.4
1 MIDS T	2361.	5.84	9.03	.275	1.61	2.48	.274	9.0	9.4
1 MIDS B	3167.	7.84	16.87	.293	2.30	4.78	.283	9.3	9.7
2 MIDS B	1461.	3.62	20.48	.294	1.36	5.84	.285	9.4	9.8
2 MIDS T	635.	1.57	22.05	.294	.46	6.30	.286	8.3	9.1
2 MIDS B	49.	.12	22.18	.295	.04	6.34	.286	8.8	9.1
2 MIDS T	266.	.66	22.83	.296	.13	6.47	.289	9.1	9.2
2 MIDS B	4380.	10.84	33.67	.304	2.35	8.82	.291	9.2	9.4
2 MIDS T	1794.	4.44	38.11	.304	1.91	11.00	.291	9.2	9.4
2 MIDS B	1090.	2.70	40.81	.337	1.35	12.00	.300	9.2	9.4
2 MIDS T	2487.	6.16	46.97	.346	2.11	14.11	.304	9.2	9.4
2 MIDS B	1881.	4.66	51.62	.346	1.61	15.72	.305	9.2	9.4
2 MIDS T	1275.	.68	52.30	.347	.02	15.95	.307	9.2	9.4
2 MIDS B	1259.	3.12	55.42	.361	1.71	17.63	.312	9.2	9.4
2 MIDS T	1919.	4.75	60.17	.386	1.55	19.18	.316	9.2	9.4
2 MIDS B	1620.	4.01	64.18	.395	1.02	20.20	.317	9.2	9.4
2 MIDS T	100.	.25	64.43	.425	.10	20.39	.317	9.2	9.4
2 MIDS B	114.	.28	65.71	.435	.12	20.51	.318	9.2	9.4
2 MIDS T	273.	.68	65.38	.514	.71	21.22	.322	9.2	9.4
2 MIDS B	556.	1.38	66.76	.542	.22	21.51	.329	9.2	9.4
2 MIDS T	906.	2.24	69.00	.806	1.22	22.73	.340	9.2	9.4
2 MIDS B	609.	1.51	70.51	1.308	3.26	27.20	.373	9.2	9.4
2 MIDS T	1006.	2.49	73.00						

STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS B	1287.	3.19	3.19	.273	.87	.87	.273	9.4	9.4
1 MIDS T	2361.	5.84	9.03	.275	1.61	2.48	.274	9.0	9.4
1 MIDS B	3167.	7.84	16.87	.293	2.30	4.78	.283	9.3	9.7
2 MIDS B	1461.	3.62	20.48	.294	1.36	5.84	.285	9.4	9.8
2 MIDS T	635.	1.57	22.05	.294	.46	6.30	.286	8.3	9.1
2 MIDS B	49.	.12	22.18	.295	.04	6.34	.286	8.8	9.1
2 MIDS T	266.	.66	22.83	.296	.13	6.47	.289	9.1	9.2
2 MIDS B	4380.	10.84	33.67	.304	2.35	8.82	.291	9.2	9.4
2 MIDS T	1794.	4.44	38.11	.304	1.91	11.00	.291	9.2	9.4
2 MIDS B	1090.	2.70	40.81	.337	1.35	12.00	.300	9.2	9.4
2 MIDS T	2487.	6.16	46.97	.346	2.11	14.11	.304	9.2	9.4
2 MIDS B	1881.	4.66	51.62	.346	1.61	15.72	.305	9.2	9.4
2 MIDS T	1275.	.68	52.30	.347	.02	15.95	.307	9.2	9.4
2 MIDS B	1259.	3.12	55.42	.361	1.71	17.63	.312	9.2	9.4
2 MIDS T	1919.	4.75	60.17	.386	1.55	19.18	.316	9.2	9.4
2 MIDS B	1620.	4.01	64.18	.395	1.02	20.20	.317	9.2	9.4
2 MIDS T	100.	.25	64.43	.425	.10	20.39	.317	9.2	9.4
2 MIDS B	114.	.28	65.71	.435	.12	20.51	.318	9.2	9.4
2 MIDS T	273.	.68	65.38	.514	.71	21.22	.322	9.2	9.4
2 MIDS B	556.	1.38	66.76	.542	.22	21.51	.329	9.2	9.4
2 MIDS T	906.	2.24	69.00	.806	1.22	22.73	.340	9.2	9.4
2 MIDS B	609.	1.51	70.51	1.308	3.26	27.20	.373	9.2	9.4
2 MIDS T	1006.	2.49	73.00						

14 PERCENT MOISTURE BASIS

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*** HRW-H      YIFLD=72.40 *****
STREAM          STR WT      PCENT      S OF Q      ASH      QXA      S OF QXA      CUM ASH      PROT      CUM PROT
1 MIDS B        1690.      4.26      4.26      .283      1.20      1.20      .283      11.2      11.20
2 MIDS B        2590.      6.34      10.78      .293      1.91      3.11      .289      10.8      10.84
3 MIDS B        1325.      3.07      14.11      .303      1.01      4.12      .300      11.6      11.07
4 MIDS B        4000.      10.14      24.19      .313      3.14      7.26      .300      11.1      11.27
5 SIZ B         54.      .83      24.32      .314      .04      7.30      .301      11.3      11.27
6 SIZ B         328.      1.86      25.15      .323      .60      7.56      .302      10.9      11.25
7 SIZ B         740.      4.85      27.01      .323      .24      8.16      .305      11.6      11.26
8 SIZ B         1925.      7.81      31.86      .329      1.57      9.73      .310      12.5      11.32
9 MIDS          3100.      7.21      39.66      .358      2.57      12.30      .318      14.4      11.51
10 MIDS          2865.      2.10      46.88      .383      2.80      14.88      .320      11.1      11.62
11 2,3 RED      833.      6.16      49.59      .400      .24      15.93      .327      15.6      11.79
12 QUAL         242.      3.56      53.15      .411      1.51      17.40      .333      12.0      12.03
13 BK           1415.      3.54      56.69      .426      1.87      18.90      .341      13.9      12.09
14 BK           1660.      4.18      60.87      .448      1.04      20.78      .346      14.1      12.23
15 SUC          907.      2.28      63.15      .456      .80      21.82      .351      14.3      12.24
16 BK BK        197.      1.53      63.63      .522      .43      22.84      .351      11.2      12.23
17 PRE          607.      .82      65.16      .525      .80      22.95      .353      12.9      12.40
18 TAILS        324.      .82      66.37      .532      .43      23.39      .362      16.3      12.54
19 MIDS         839.      1.11      68.30      .639      1.20      24.74      .371      19.3      12.40
20 BK           635.      1.60      69.90      .753      3.51      25.94      .407      16.3      12.54
21 B AND SD     994.      2.50      72.40      1.403      3.51      29.45      .407      16.3      12.54

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STREAM WT      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
PCENT Q        .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
ASH            .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
QXA            .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
S OF QXA       .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
CUM ASH        .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
PROT           .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
CUM PROT       .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .
*              .      .      .      .      .      .      .      .      .      .      .      .      .      .      .      .

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STREAM WEIGHT (GRAMS/5 MINUTES
 PERCENT OF TOTAL PRODUCTS
 SUM OF TOTAL PRODUCTS
 PERCENT OF TOTAL PRODUCTS *
 (PERCENT OF TOTAL PRODUCTS) X (ASH)
 SUM OF QXA
 CUMULATIVE ASH (S OF QXA)/(S OF Q)
 CUMULATIVE PERCENT OF SAMPLE WEIGHT *
 CUMULATIVE PERCENT OF SAMPLE WEIGHT *
 CUMULATIVE PERCENT OF SAMPLE WEIGHT *
 14 PERCENT MOISTURE BASIS

**** HRW-1 YIELD=75.82 ****

STREAM	SIR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS T	3747.	9.61	9.01	269	2.59	2.59	269	9.4	9.38
2 MIDS B	52.	1.13	9.74	299	.04	2.63	270	10.9	9.39
3 MIDS B	1067.	2.74	15.48	300	.82	3.45	276	9.9	9.51
4 MIDS T	1195.	3.07	15.55	301	.92	4.37	281	9.6	9.53
5 MIDS T	1773.	1.98	17.53	303	.60	4.97	284	9.2	9.49
6 MIDS T	4420.	11.34	31.87	310	3.51	8.49	295	10.4	9.85
7 MIDS T	920.	12.37	31.24	311	.74	9.22	300	10.7	9.82
8 MIDS B	5040.	12.93	44.16	311	4.02	13.29	300	9.6	9.82
9 MIDS B	5055.	1.14	44.31	331	.05	13.29	305	11.0	9.95
10 MIDS RED	2143.	5.50	49.80	349	1.92	15.21	307	10.0	9.95
11 PK	7745.	1.91	51.71	353	.67	15.88	311	10.2	9.95
12 PK	1379.	3.54	55.25	374	1.32	17.20	316	11.4	9.95
13 PK	1333.	3.42	58.67	383	1.31	18.51	319	10.7	10.07
14 PK	1035.	2.65	61.32	384	1.02	19.53	319	10.0	10.04
15 PK	290.	4.79	62.07	399	.30	19.83	326	10.7	10.09
16 PK	1868.	4.51	66.86	406	1.95	21.78	328	12.9	10.15
17 PK	590.	1.51	68.37	432	.65	22.43	330	9.9	10.14
18 PK	388.	1.00	69.37	451	.09	22.88	330	10.4	10.14
19 PK	70.	1.18	69.55	490	.09	23.06	331	15.4	10.27
20 PK	75.	1.80	69.74	504	.06	24.12	337	11.7	10.31
21 PK	703.	1.98	71.54	587	1.06	25.18	350	13.0	10.39
22 PK	773.	1.98	73.52	805	1.60	26.78	375		
23 PK	895.	2.30	75.82	1190	2.73				

STREAM WEIGHT (GRAMS/5 MINUTES
 PERCENT OF TOTAL PRODUCTS
 SUM OF PERCENT OF TOTAL PRODUCTS
 PERCENT OF SAMPLE WEIGHT *
 (PERCENT OF TOTAL PRODUCTS) X (ASH)
 SUM OF QXA
 CUMULATIVE PERCENT OF SAMPLE WEIGHT *
 PROTEIN, PERCENT
 CUMULATIVE PERCENT
 14 PERCENT MOISTURE BASIS

**** HRW-2 YIELD=74.57 *****

STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS B	2025.	4.86	4.86	.272	1.32	1.32	.272	9.9	9.88
1 MIDS T	3409.	8.18	13.04	.281	2.30	3.62	.278	9.6	9.73
1 F SIZ B	82.	.20	13.23	.291	2.66	3.68	.278	9.7	9.73
2 MIDS T	4123.	9.89	23.13	.291	2.88	6.56	.285	10.8	9.86
2 MIDS B	1387.	3.33	26.45	.291	3.17	7.53	.285	9.8	9.86
3 MIDS	4609.	11.06	37.51	.309	3.41	10.94	.292	10.3	9.98
3 C SIZ B	31.	.07	37.59	.309	3.62	10.96	.292	10.0	9.98
3 C SIZ T	1250.	3.00	40.59	.313	3.94	11.90	.293	9.9	9.97
3 C SIZ T	596.	1.43	42.02	.321	4.46	11.36	.294	10.4	9.98
1,2,3 RED	916.	2.20	44.21	.335	4.74	13.10	.296	10.3	10.00
2 BK	1642.	3.94	48.15	.336	1.32	14.42	.299	10.5	10.04
2 BK	3342.	1.97	50.12	.355	2.70	15.12	.302	10.5	10.01
4 MIDS	1529.	3.67	58.14	.357	2.86	17.98	.309	11.1	10.16
3 BK	27.	.06	61.81	.384	1.41	19.39	.314	12.2	10.28
PRET	122.	.29	61.88	.449	1.03	19.42	.314	9.4	10.28
SUCTION	468.	1.12	62.17	.465	1.14	19.56	.315	10.8	10.29
4 BK	1371.	3.29	63.29	.502	1.65	20.08	.317	13.6	10.34
5 MIDS	246.	.59	66.58	.536	1.32	21.74	.326	10.9	10.37
2 QUAL	276.	.66	67.17	.621	1.41	22.05	.328	10.2	10.37
1 TAILS	628.	1.51	67.83	.687	1.90	22.46	.331	15.6	10.48
5 BK	1013.	2.43	71.77	.783	1.90	23.50	.339	11.7	10.53
6 MIDS	1167.	2.80	74.57	1.481	4.15	25.40	.354	13.9	10.53

STREAM WEIGHT (GRAMS/5 MINUTES
 PERCENT OF TOTAL PRODUCTS
 SUM OF PERCENT OF TOTAL PRODUCTS
 SUM OF PERCENT OF SAMPLE WEIGHT *
 (PERCENT OF TOTAL PRODUCTS) X (ASH)
 SUM OF QXA
 CUMULATIVE ASH (S OF QXA)/(S OF Q)
 CUMULATIVE PERCENT OF SAMPLE WEIGHT *
 CUMULATIVE PERCENT OF PROTEIN
 CUMULATIVE PERCENT MOISTURE BASIS

**** HRW-3		YIELD=74.95		****					
STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS B	1891.	4.81	4.81	282	1.36	1.36	282	8	78
2 MIDS T	4569.	11.61	16.42	291	3.38	4.74	288	9.8	87
3 MIDS R	3306.	8.06	24.87	292	3.45	7.19	290	9.5	97
4 MIDS B	4073.	10.35	35.22	310	3.02	10.20	296	9.4	106
5 MIDS B	54.	0.21	35.44	312	3.21	13.41	297	10.7	116
6 MIDS B	1370.	3.48	38.92	312	1.09	14.50	298	9.8	126
7 MIDS T	871.	1.70	40.63	321	1.53	16.03	299	9.6	135
8 MIDS T	2232.	2.21	42.83	340	1.71	17.74	304	9.7	145
9 MIDS	845.	5.67	48.50	355	1.93	19.67	306	10.6	155
10 BK	1554.	2.15	50.65	375	1.48	21.15	311	10.8	165
11 BK	902.	3.95	54.60	395	1.91	23.06	314	9.9	175
12 BK TAILS	303.	2.77	57.37	400	1.32	24.38	316	9.7	184
13 BK	1636.	4.16	61.53	419	1.77	26.15	322	13.0	197
14 MIDS	1665.	4.23	65.76	419	1.77	27.92	328	10.1	207
15 QUAL	1298.	0.76	66.51	478	1.36	29.28	330	9.8	216
16 SUCTION	88.	0.22	67.03	526	0.12	29.40	331	10.6	226
17 PRE BK	56.	0.14	67.17	547	0.08	29.48	331	9.9	236
18 BK	570.	1.45	68.62	554	0.80	30.28	336	15.3	251
19 MIDS	1119.	2.84	71.46	703	2.00	32.28	350	10.5	261
20 BK	476.	1.21	72.67	772	0.93	33.21	358	16.4	277
21 B AND SD	896.	2.28	74.95	1387	3.16	36.41	389	13.5	290

STREAM	STR WT	PCENT	S OF Q	ASH	QXA	S OF QXA	CUM ASH	PROT	CUM PROT
1 MIDS B	1891.	4.81	4.81	282	1.36	1.36	282	8	78
2 MIDS T	4569.	11.61	16.42	291	3.38	4.74	288	9.8	87
3 MIDS R	3306.	8.06	24.87	292	3.45	7.19	290	9.5	97
4 MIDS B	4073.	10.35	35.22	310	3.02	10.20	296	9.4	106
5 MIDS B	54.	0.21	35.44	312	1.09	13.41	297	10.7	116
6 MIDS B	1370.	3.48	38.92	312	1.09	14.50	298	9.8	126
7 MIDS T	871.	1.70	40.63	321	1.53	16.03	299	9.6	135
8 MIDS T	2232.	2.21	42.83	340	1.71	17.74	304	9.7	145
9 MIDS	845.	5.67	48.50	355	1.93	19.67	306	10.6	155
10 BK	1554.	2.15	50.65	375	1.48	21.15	311	10.8	165
11 BK	902.	3.95	54.60	395	1.91	23.06	314	9.9	175
12 BK TAILS	303.	2.77	57.37	400	1.32	24.38	316	9.7	184
13 BK	1636.	4.16	61.53	419	1.77	26.15	322	13.0	197
14 MIDS	1665.	4.23	65.76	419	1.77	27.92	328	10.1	207
15 QUAL	1298.	0.76	66.51	478	1.36	29.28	330	9.8	216
16 SUCTION	88.	0.22	67.03	526	0.12	29.40	331	10.6	226
17 PRE BK	56.	0.14	67.17	547	0.08	29.48	331	9.9	236
18 BK	570.	1.45	68.62	554	0.80	30.28	336	15.3	251
19 MIDS	1119.	2.84	71.46	703	2.00	32.28	350	10.5	261
20 BK	476.	1.21	72.67	772	0.93	33.21	358	16.4	277
21 B AND SD	896.	2.28	74.95	1387	3.16	36.41	389	13.5	290

14 PERCENT MOISTURE BASIS

APPENDIX C

INDIVIDUAL FLOUR STREAM WEIGHTS FROM SEVERAL HARD RED WINTER
WHEATS, PERCENT OF TOTAL PRODUCTS

FLOUR STREAMS, K.S.U. PILOT FLOUR MILL, PERCENT OF TOTAL PRODUCT

Flour Stream	Wheat Mix				Mean
	HRW-L	HRW-H	HRW	HRW	
Pre Bk	.247	.231	.226	.206	.131
1 Bk	2.697	2.717	2.298	2.283	2.422
2 Bk	4.655	4.829	3.341	3.563	3.869
3 Bk	4.009	4.183	3.535	3.537	3.739
1,2,3 Red	3.116	3.269	2.183	2.097	2.178
C Siz T	1.571	1.577	1.901	1.863	1.849
C Siz B	.121	.124	.129	.135	.108
F Siz T	4.440	4.441	4.986	4.847	2.950
F Siz B	.658	.690	.895	.825	.340
1 Mids T	5.843	5.859	6.482	6.521	8.318
1 Mids B	3.185	3.517	4.235	4.255	3.914
2 Mids T	10.840	10.939	9.710	10.072	11.480
2 Mids B	3.615	3.591	2.995	3.336	3.123
2 Qual	.680	.688	.542	.609	.693
4 Bk	1.376	1.301	1.542	1.528	1.402
3 Mids	7.838	7.566	7.597	7.806	10.031
1 Tails	.675	.740	.542	.815	.818
4 Mids	6.155	6.257	7.869	7.214	6.473
Suction	.282	.365	.430	.483	.330
5 Bk	1.507	1.264	1.318	1.598	1.501
5 Mids	4.749	4.789	4.245	4.180	4.162
B and SD	2.489	2.056	2.949	2.502	2.475
6 Mids	2.242	1.997	2.428	2.112	2.304

FLOUR STREAMS, K.S.U. PILOT FLOUR MILL, PERCENT OF TOTAL PRODUCT

Flour Stream	Wheat Mix						Mean			
	HRW-1	HRW-2	HRW-3	HRW-3	HRW-3	HRW-3				
Pre Bk	.017	.180	.012	.179	.071	.064	.076	.075	.142	.131
1 Bk	2.793	2.500	2.727	2.653	2.021	1.972	2.162	2.291	2.293	2.422
2 Bk	3.527	3.542	3.427	3.536	3.967	3.941	4.025	4.333	3.951	3.869
3 Bk	3.463	3.370	3.468	3.418	3.654	3.669	3.771	4.187	4.159	3.739
1,2,3 Red	1.903	1.740	1.803	1.910	2.248	2.198	2.263	2.036	2.148	2.178
C S1z T	2.411	2.490	2.362	2.371	1.453	1.430	1.467	1.782	1.701	1.849
C S1z B	.143	.152	.128	.141	.076	.074	.079	.065	.058	.108
F S1z T	1.700	1.677	1.695	1.982	3.010	3.000	3.001	1.956	2.214	2.950
F S1z B	.153	.182	.133	.133	.233	.196	.221	.090	.213	.340
1 Mids T	9.800	9.813	9.503	9.608	8.331	8.182	8.256	8.044	8.406	8.318
1 Mids B	3.032	3.067	2.920	3.064	5.012	4.860	5.161	4.786	4.808	3.914
2 Mids T	13.089	13.110	13.307	12.923	9.729	9.895	9.877	11.826	11.617	11.480
2 Mids B	2.491	2.800	2.663	2.735	3.267	3.329	3.352	3.562	3.483	3.123
2 Qual	.800	.967	.800	.742	.537	.590	.565	.953	.757	.693
4 Bk	1.385	1.437	1.469	1.512	1.152	1.123	1.125	1.427	1.449	1.402
3 Mids	11.044	11.125	11.374	11.333	11.353	11.062	9.824	10.453	10.356	10.031
1 Tails	1.180	1.050	.980	.994	.699	.662	.610	.873	.770	.818
4 Mids	6.041	5.462	5.612	5.495	7.863	8.021	8.176	5.725	5.675	6.473
Suction	.461	.437	.347	.192	.451	.292	.353	.173	.223	.330
5 Bk	1.439	1.467	1.430	1.802	1.594	1.507	1.594	1.115	1.210	1.501
5 Mids	4.656	4.840	5.085	4.789	2.711	3.290	3.090	4.270	4.233	4.162
B and SD	2.296	2.250	2.349	2.294	2.685	2.801	2.902	2.253	2.278	2.475
6 Mids	1.965	2.132	2.192	1.982	2.470	2.431	2.640	2.714	2.845	2.304

THE DISTRIBUTION AND ANALYSIS OF ALL THE STREAMS ON THE
KANSAS STATE UNIVERSITY PILOT FLOUR MILL

by

LESLIE ARTHUR LOVETT

B. S., Kansas State University, 1965

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Grain Science and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1967

This study investigated quantitatively the distributions of stock of several different wheats to and from each milling machine in a production scale flour mill to collect data that would be useful in evaluating milling systems and in designing new mills. One hundred thirteen samples were collected and analyzed while milling one lot of each class of wheat.

Nine samples of wheat from four classes were milled on the Kansas State University Pilot Flour Mill. Five of the samples were hard red winter wheats, two were hard red spring wheats, one was a soft red winter, and one was a soft white wheat. Each wheat sample was milled in test for 9-12 hours.

Samples of every stream in the pilot flour mill were collected for five minute periods while the spring wheats or the soft wheats were being milled. The samples were weighed and each was analyzed for moisture, ash, and protein. Data from a 1964 report¹ on the milling of hard red winter wheats were used here. In this study the individual flour streams and the millfeed streams from the five hard red winter wheats were collected and analyzed.

Care was taken to duplicate the temperature and relative humidity of the air in the mill when milling each sample. It was necessary to mill the soft wheats more slowly and at a lower moisture than the hard wheats. The same break release schedule was used for all the wheats. The only change in the break system was made in the break redust sifter section where two flour cloths with larger openings than usual were added when milling the

¹E. P. Farrell and A. B. Ward. Flow rates and analyses for ash and protein of all streams in the Kansas State University pilot mill. Association of Operative Millers Bul., March, 1964, pp. 2842-2847.

soft wheats. Coarser sifter clothing was installed in the third and fourth middlings sifters for use when milling Gaines and the two hard red spring wheats. The need for this was shown by the results of the milling of soft red winter wheat.

Throughout the mill the distribution of stock from both classes of hard wheat milled were similar except that the hard red spring wheat made slightly less break flour and more coarse middlings. This indicated that the spring wheat was harder to reduce than the winter wheat because of the generally stronger nature of the spring wheat endosperm. The break granulation curves from both classes of hard wheats were fairly straight and could be approximated by a straight line for design purposes.

The soft wheats performed on the mill quite differently than the hard wheats. The endosperm of the soft wheats reduced much more easily but sifted more slowly than that from either of the hard wheat classes. The granulation curves of the break stocks obtained from the soft wheats were more concave than those from the hard wheats. A straight line does not give a satisfactory approximation of the granulation of ground break stocks from soft wheat.

The cumulative ash curves obtained from the four classes of wheat showed no grouping along class lines or between hard and soft wheats.

The flow weights of the individual flour streams showed consistency for a given wheat but varied over a much wider range when comparing one wheat with another. The flour stream weights from all the hard red winter wheats were used to calculate a mean and standard deviation for the flour production of every flour stream in the pilot mill. These data will be of

value in future tests on the Kansas State University Pilot Flour Mill to determine the feasibility of controlling the mill by flour production alone.